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# FRUIT PRODUCTION

Recommendations

**2000-2001**

P u b l i c a t i o n   3 6 0



Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the sub-committee, all of these pesticides were:

- federally registered
- reviewed by the Ontario Pesticides Advisory Committee and
- classified by the Ministry of the Environment as of November, 1999.

#### **Discard old editions of this publication.**

The information in this publication is general information only. All pesticides must be used in accordance with the product label and *Regulation 914* of the *Ontario Pesticides Act*.

#### **Pay close attention to all instructions and warnings on the pesticide label.**

By printing this publication, the Ministry of Agriculture, Food and Rural Affairs does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

#### **Policy Statement**

In this publication, most recommendations list several pesticides that can be used for each pest discussed. In general:

- the least hazardous materials and those that growers have used satisfactorily for years are listed first;
- the more toxic pesticides and/or newer ones with less practical, grower experience follow.

#### **In some cases, the most effective pesticides are highly toxic.**

This publication lists a number of brand names of pesticides. This is for the grower's convenience only. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, and so on. Wettable or soluble powders (WP, SP, WDG or DG) are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

Health Canada has established maximum residue limits (MRLs) for pesticides. However, growers should be aware that processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market as to which restrictions or limitations apply.

#### **Federal Registration and Provincial Classification**

The Ministry of the Environment administers Ontario's *Pesticides Act* and *Regulation 914*.

All pesticides sold and used in Ontario must be:

- registered under the federal *Pest Control Products Act*, and
- classified under the provincial *Pesticides Act* by being placed in one of six schedules of the Ontario regulation.

#### **Federal Registration**

There are three federal registration categories.

##### **1. Full Registration**

The federal government agrees the data package was acceptable at the time of registration.

##### **2. Temporary Registration**

Additional scientific or technical information is required to obtain full registration. Temporary registrations expire after a specified time (one or two years).

##### **3. Temporary Registration (Restricted Class)**

While the pesticide is urgently needed, studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered yearly.

#### **Provincial Classification**

There are six classification schedules in *Regulation 914*. Pesticide products are classified on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration, and usage. This system is needed to regulate the distribution, availability and use of pesticide products in Ontario.

For up-to-date information on the regulatory status of these or other pesticides contact the:

Pesticides Section,  
Standards Development Branch,  
Ministry of the Environment, Toronto.  
Telephone (416) 327-5519

#### **Farmer Certification**

Agriculturists must be certified through the Grower Pesticide Safety Course to purchase and use Schedule 1, 2 or 5 pesticides. Effective January 1, 2000 agricultural assistants must complete Ministry of the Environment-approved training before they can handle Schedule 2 or 5 products under the supervision of a Certified Grower. Trained Assistants also have some restrictions of duties. For more information please call the Ontario Pesticide Education Program at 1-800-653-8573.

*Cette publication est aussi disponible en français.*

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P u b l i c a t i o n   3 6 0

### **Looking for fruit production recommendations on the Internet?**

**[www.gov.on.ca/omafra/english/crops/index.html](http://www.gov.on.ca/omafra/english/crops/index.html)**

It's one-stop shopping for factsheets, articles and photos regarding the production and maintenance of Ontario's fruit crops.

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### **Acknowledgements**

The recommendations contained in this publication have been prepared in consultation with:

- Ontario Pest Management Research & Services Committee
- Ontario Horticultural Research & Services Committee
- Ontario Soil Management Research & Services Committee
- Ontario Weed Committee

and personnel of:

- Crop Technology, OMAFRA
  - University of Guelph
  - Ontario Ministry of Environment
  - Agriculture and Agri-Food Canada
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# Contents

<b>1. Using Pesticides Safely</b>		
General Precautions with All Pesticides .....	1	
Preventing Water Supply Contamination .....	1	
If an Accident Occurs .....	2	
Relative Toxicity to Applicator .....	2	
Entering Treated Areas .....	3	
Blood Tests for those Applying Pesticides .....	3	
Protective Outdoor Clothing .....	3	
Why Use Personal Protection? .....	3	
Reducing Exposure .....	3	
Protective clothing .....	4	
Respirators .....	4	
Washing Protective Clothing and Equipment .....	5	
Protection for Grain Storage and Enclosed Areas .....	5	
Canister Gas Masks .....	5	
Self-Contained Breathing Apparatus .....	5	
Other Protective Clothing .....	6	
Working Conditions .....	6	
Space Fumigants and Insecticide Smokes .....	6	
Storing Pesticides .....	7	
Schedule 1, 2 and 5 Pesticides .....	7	
Disposal of Containers and Contaminated Materials .....	7	
<b>2. Pesticide Application</b>		
Spray Application Technology .....	8	
New Technologies .....	8	
Sprayers for Home Use .....	8	
Field Sprayers .....	8	
Air Blast or Mist Sprayers .....	8	
Wiper Applicators for Selective Weed Control .....	8	
Equipment Use and Care .....	8	
Spraying Speeds .....	8	
Using Water Correctly .....	8	
Agitation .....	9	
Preparing a Wettable Powder and Oil or Emulsifiable		
Concentrate Mix .....	9	
Using Products in Water Soluble Packaging .....	9	
Handling .....	9	
Mixing .....	9	
Compatibility .....	10	
Pumps .....	10	
Nozzles .....	10	
Flat-Fan Nozzle Tips .....	10	
Flooding-Fan Nozzle Tips .....	10	
Broadcast Nozzle Tips .....	11	
Full and Hollow Cone Nozzle Tips .....	11	
Nozzle Screens .....	11	
Environmental Issues when Cleaning .....	11	
Cleaning the Sprayer .....	11	
Sprayer Calibration .....	11	
Boom Sprayer Calibration .....	11	
Guide for Spraying Tree Fruits .....	12	
Airblast Sprayer Calibration .....	13	
Pesticide Injury to Crops .....	13	
Application by Airplane or Helicopter .....	14	
Pesticide Drift .....	14	
<b>3. Soil Management and Fertilizer Use</b>		
Soil Testing .....	15	
Other Methods of Assessing Nutrient Needs .....	15	
Benefits of the OMAFRA Accredited Soil Testing Program .....	15	
Soil Sampling .....	15	
Micronutrient Tests .....	16	
Contamination .....	16	
Soil Sampling .....	16	
Plant Analysis .....	17	
Sampling .....	17	
Sample Preparation .....	17	
Fertilizer Recommendations .....	17	
Nitrogen .....	17	
Phosphate and potash .....	17	
Soil Acidity And Liming .....	18	
The Buffer pH .....	18	
Limestone Quality .....	19	
The Agricultural Index .....	19	
Tillage Depth .....	20	
Lowering Soil pH .....	20	
Managing Soil Organic Matter .....	20	
Adjustments to Fertilizer Recommendations .....	20	
Adjustment for Legumes Plowed Down .....	20	
Manure .....	21	
Value of Manure .....	21	
Manure Analysis .....	21	
Long Term Value of Manure .....	22	
Environmental Concerns with Manure .....	22	
Food Safety Concerns with Manure Application & Timing .....	22	
Fertilizer Materials .....	23	
Soluble Salts In Farm Soils .....	23	
Fertilizer Placement .....	24	
Water Quality .....	24	
Bacteria Contamination .....	24	
Soil Erosion .....	24	
Nitrate Contamination .....	25	
Pesticide Contamination .....	25	
Fuel contamination .....	25	
<b>4. Pest Management</b>		
Integrated Pest Management .....	26	
Pest Resistance to Insecticides, Fungicides, Miticides .....	26	
Insecticides .....	27	
Organophosphates .....	27	
Synthetic Pyrethroids .....	27	
Lannate .....	27	
Fungicides .....	27	
Benlate/Senator .....	27	
Equal .....	27	
Rovral .....	27	
Ronilan .....	28	
Miticides .....	28	
Kelthane .....	28	
Apollo .....	28	
Nematodes .....	28	
Nematodes in Berry Crops .....	28	
Nematodes in Tree Fruits .....	29	

Nematode Control .....	29
Application of Fumigants .....	30
Single Tree Sites for Replacement Trees .....	30
VYDATE L — Post-Plant Treatment .....	30
Non-Bearing Apples .....	30
Raspberries .....	31
Wildlife Control .....	31
Bird Damage and its Prevention in Fruit Crops .....	31
Methods of Bird Control .....	31
Location .....	31
Physical Protection .....	31
Shooting .....	31
Automatic Exploders .....	32
Electronic Sound Devices .....	32
Chemical Controls .....	32
Visual Deterrents .....	32
Falconry .....	32
Rodent and Deer Control in Orchards .....	32
Bait for Mouse and Vole Control .....	32
Wrapping Young Trees .....	32
Repellents .....	32
Deer Removal Permit Program .....	33
Repairing Damage by Mice and Rabbits .....	33
Control of Southwest Injury on Fruit Trees .....	33
Use of Copper Products on Fruit Crops .....	34
Chemical Characteristics of Copper Fungicides .....	34
Procedures To Tank-Mix Copper Formulations and Lime ...	34
Registration Status and Availability of Copper .....	
Fungicide Products .....	34
<b>5. Ground Cover Management</b> .....	
Adaptation and Use of Cover Crops .....	37
Grasses .....	37
Spring Cereals .....	37
Winter Wheat .....	37
Sorghum Sudan .....	37
Winter Rye .....	37
Legumes .....	37
Non-Legume Broadleaves .....	38
Buckwheat .....	38
Oilseed Radish .....	38
Sod Covers for Orchards, Vineyards and Brambles .....	38
Temporary .....	38
Permanent .....	38
<b>6. Pollination and Bee Poisoning Prevention</b> .....	
Pollination Requirements for Fruit Crops .....	40
Apples .....	40
Apricots .....	40
Blueberries .....	40
Sour Cherries .....	40
Sweet Cherries .....	40
Currants and Gooseberries .....	40
Grapes .....	40
Peaches and Nectarines .....	40
Pears .....	40
Plums .....	40
Raspberries and Blackberries .....	40
Strawberries .....	40
Tree Nut Crops .....	40

Using Honey Bees Effectively .....	40
Recommended Publications .....	41
Bee Poisoning .....	41
<b>7. Apples</b> .....	
<b>Apple Nutrition</b> .....	44
Manure for Orchards .....	44
pH Requirements .....	44
Leaf Analysis .....	44
Fertilizer for Apples .....	45
Fertilizer for Non-bearing Apples .....	46
Fertilizer for Bearing Apples .....	45
Nitrogen (N) .....	46
Phosphorous (P) .....	46
Potassium (K) .....	46
Magnesium (Mg) .....	47
Calcium (Ca) .....	48
Micronutrients for Apples .....	49
Boron (B) .....	49
Manganese (Mn) .....	49
Iron (Fe) .....	50
Zinc (Zn) .....	50
<b>APPLE CALENDAR</b> .....	51
<b>Apple Disease Control Notes</b> .....	59
Managing Apple Scab .....	59
Primary Infection Periods .....	59
Secondary Infection Periods .....	60
Apple Scab Management with Fungicides .....	61
Early Season Management .....	61
Protectant fungicide program .....	61
Pre-symptomatic (after-infection) sprays .....	61
Use of Sterol-Inhibiting Fungicides .....	62
Control Under Adverse Weather Conditions .....	63
Deactivation of Established Scab Lesions .....	63
Secondary Scab Management .....	63
Fire Blight of Apple .....	63
Predicting Fire Blight Infections .....	64
Cultural Practices .....	64
Chemical Control .....	64
Phytophthora Collar Rot Control .....	64
Blue Mould and Gray Mould in Stored Apples .....	65
Reducing Disease Development .....	65
Post Harvest Treatment .....	65
<b>Apple Thinning and Growth Regulators</b> .....	66
Chemical Thinning of Apples .....	66
Chemicals Available for Thinning .....	66
Environmental Conditions .....	67
Spray Concentration .....	67
Length of Wetting Period for Material Absorption .....	68
Factors Influencing Response to Thinning Agents .....	68
Timing of Application .....	69
Sampling Method .....	69
Steps in Thinning .....	69
Cultivar Notes .....	70
Suggested Rates for Chemical Thinning of Apples .....	70
Defruiting Immature Apple Trees .....	70
Promalin to Improve Fruit Shape of Delicious .....	70
Ethephon to Promote Fruit Colouring .....	71
Chemical Control of Preharvest Drop of Apples .....	72
Recommendations for Use of ReTain .....	72



<b>8. Berry Crops</b>		<b>Raspberry &amp; Blackberry Insect Control Notes</b>	<b>90</b>
<b>Berry Crop Nutrition</b>	<b>74</b>	Raspberry Cane Borer	90
Strawberries	74	Red-Necked Cane Borer	90
pH requirements	74	Sap Beetles	90
Fertilizer for New Plantings (the planting year)	74	<b>STRAWBERRY CALENDAR</b>	<b>91</b>
Phosphorus (P)	74	Establishment Year — New Plantings	91
Potassium (K)	74	CULTURAL CONTROL	91
Nitrogen (N)	74	CHEMICAL CONTROL	92
Fertilizer for Established Plantings	75	Bearing Years	93
Nitrogen (N)	75	CULTURAL CONTROL	93
Phosphorus (P)	75	CHEMICAL CONTROL	93
Potassium (K)	76	<b>Strawberry Insect Control Notes</b>	<b>96</b>
Leaf Analysis for Strawberries	76	White Grubs	96
Raspberries	76	Fruit Bronzing Caused by Thrips	96
pH Requirements	76	Root Weevils	96
Fertilizer for Raspberries	76	<b>Strawberry Disease Control Notes</b>	<b>97</b>
Nitrogen (N)	76	Leather Rot	97
Phosphorus (P) and Potassium (K)	76	Angular Leaf Spot	97
Currents and Gooseberries	77	Nematodes	97
pH Requirements	77		
Fertilizer Before Planting	77	<b>9. Grapes</b>	
Nitrogen (N)	77	<b>Grape Nutrition</b>	<b>101</b>
Phosphorus (P)	77	Manure for Vineyards	101
Potassium (K)	77	pH Requirements	101
Fertilizer in Established Plantings	77	Petiole Analysis for Grapes	101
Nitrogen (N)	77	Fertilizer for Grapes	102
Potassium (K)	77	Nitrogen (N)	102
Highbush Blueberries	77	Phosphorus (P)	103
pH Requirements	78	Potassium (K)	103
Fertilizer for Blueberries	78	Magnesium (Mg)	103
Nitrogen (N)	78	Calcium (Ca)	103
Phosphorus (P) and Potassium (K)	78	Micronutrients for Grapes	104
Other nutrient requirements	78	Boron (B)	104
Leaf Analysis	78	Manganese (Mn)	104
Micronutrients for Berry Crops	79	Iron (Fe)	104
Boron (B)	79	Zinc	104
Manganese (Mn)	79	<b>GRAPE CALENDAR</b>	<b>105</b>
Iron (Fe)	79	<b>Grape Insect Control Notes</b>	<b>109</b>
Blueberries	79	Mating Disruption Technology (MD) for	
Zinc (Zn)	79	Grape Berry Moth	109
<b>BLUEBERRY CALENDAR</b>	<b>80</b>	<b>Grape Disease Control Notes</b>	<b>110</b>
<b>Blueberry Disease Control Notes</b>	<b>82</b>	Use of Nova 40 W on Grapes	110
Stern cankers	82	Crown Gall Disease of Grapevine	110
<b>Blueberry Insect Control Notes</b>	<b>82</b>	Cultural Practices for Crown Gall Control	110
Blueberry Maggot	82	Relative Disease Susceptibilities	111
White Grubs	83		
Pheromone Traps for Monitoring Cranberry Fruitworm	83	<b>10. Tender Fruit (Stone Fruit and Pears)</b>	
Bird Control	83	<b>Tender Fruit Nutrition</b>	<b>114</b>
<b>CURRENT &amp; GOOSEBERRY CALENDAR</b>	<b>84</b>	Fertilizer for Tender Fruits (Stone Fruit and Pears)	114
<b>Current Disease Control Notes</b>	<b>85</b>	Manure for Orchards	114
Powdery Mildew	85	pH Requirements for Tender Fruit	114
White Pine Blister Rust	85	Leaf Analysis for Tender Fruit	115
<b>RASPBERRY &amp; BLACKBERRY CALENDAR</b>	<b>86</b>	Fertilizer for Tender Fruit	115
<b>Raspberry &amp; Blackberry Disease Control Notes</b>	<b>88</b>	Fertilizer for Non-Bearing Tender Fruit	115
Cultural Practices for the Control of Root, Cane and		Fertilizer for Bearing Tender Fruit	116
Fruit Rot Diseases	88	Nitrogen (N)	116
Viruses	88	Nitrogen Placement and Timing	116
Crown Gall and Cane Gall	88	Foliar Application of Nitrogen for Tender Fruit	116
Verticillium Wilt (bluestem)	88	Phosphorus (P)	117
Orange Rust of Blackberry	89	Potassium (K)	117
Fire Blight	89	Placement and Timing	117
Phytophthora Root Rot	89	Foliar Application of Potassium for Tender Fruit	117
Cane Blight	90	Magnesium (Mg)	117
		Calcium (Ca)	118

Micronutrients for Tender Fruit .....	118
Boron (B) .....	118
Manganese (Mn) .....	118
Manganese toxicity .....	119
Iron (Fe) .....	119
Zinc (Zn) .....	119
<b>Stone Fruit Fungicides Notes</b> .....	120
Brown Rot Control .....	120
Development of Resistance .....	120
Management of Resistance .....	120
<b>APRICOT CALENDAR</b> .....	123
<b>Apricot Disease Control Notes</b> .....	124
Verticillium wilt .....	124
Bacterial spot .....	124
<b>Apricot Insect Control Notes</b> .....	124
Oblique-banded Leafroller .....	124
Oriental Fruit Moth .....	124
Peach Tree Borers .....	124
<b>SOUR CHERRY CALENDAR</b> .....	125
<b>Growth Regulator Notes</b> .....	127
Ethephon to Promote Fruit Loosening of Sour Cherries ..	127
Cherry Yellow Virus and Use of Gibberellic Acid on Sour Cherry .....	127
<b>Sour Cherry Disease Control Notes</b> .....	127
<b>SWEET CHERRY CALENDAR</b> .....	128
<b>PEACH &amp; NECTARINE CALENDAR</b> .....	130
<b>Non-Bearing Plantings</b> .....	135
Southwest Injury and Rodent Control .....	135
<b>Peach &amp; Nectarine Insect Control Notes</b> .....	135
Plant Bugs .....	135
<b>Peach &amp; Nectarine Disease Control Notes</b> .....	136
Peach Canker .....	136
<b>Thinning Peaches</b> .....	136
<b>PEAR CALENDAR</b> .....	138
<b>Plum Disease Control Notes</b> .....	142
Fire Blight of Pear .....	142
Blue Mould and Gray Mould in Stored Pears .....	142
<b>Thinning Pears</b> .....	143
<b>PLUM CALENDAR</b> .....	144
<b>Plum Disease Control Notes</b> .....	146
Heat Spot .....	146
<b>Plum Thinning Notes</b> .....	146
Thinning Plums .....	146
 <b>11. Tree Nuts</b>	
<b>WALNUT CALENDAR</b> .....	147
<b>FILBERT/HAZELNUT CALENDAR</b> .....	147

## 12. Weed Management for Fruit Crops

<b>Principles of Integrated Weed Management</b> .....	148
Crop Rotation .....	148
Cover Crops .....	148
Intercropping .....	148
Nitrogen Fertility .....	148
Planting Patterns .....	148
Tillage System .....	148
Critical Period of Weed Control .....	149
Herbicide Band Applications .....	149
Economic Thresholds .....	149
<b>Mechanical Methods of Weed Control</b> .....	149
Preemergent or "Blind" Harrowing .....	149
Weeder Harrow .....	149
Rotary Hoe .....	149
Inter-Row Cultivation .....	150
Mowing .....	150
<b>HERBICIDES FOR FRUIT CROPS</b> .....	150
<b>Special Methods of Weed Control</b> .....	164
<b>Horticultural Crops</b> .....	167
<b>Cultural Weed Control in Fruit Crops</b> .....	168
<b>Weed Control Calendars</b>	
Apples .....	169
Apricots .....	173
Cherries & Plums .....	176
Grapes .....	179
Peaches .....	181
Pears .....	184
Blueberries, Highbush .....	188
Cranberries .....	190
Currants and Gooseberries .....	192
Raspberries .....	192
Strawberries .....	194
Water Weeds .....	203

## 13. Pesticide Tables

<b>Pesticides Used on Fruit Crops in Ontario</b> .....	206
<b>Ontario Classification Schedules</b> .....	212
<b>Compatibility of Spray Materials</b> .....	212
<b>Number of Days from Last Spray to Harvest</b> .....	214
<b>Pesticide Manufacturers/Agents</b> .....	216

## Appendices

<b>A: Accredited Soil Testing Laboratories</b> .....	217
<b>B: Ontario Ministry of the Environment Pesticides     Control Offices</b> .....	218
<b>C: Other Contacts</b> .....	219
<b>D: List of Monitoring Equipment and Biological     Agent Suppliers</b> .....	220
<b>E: Diagnostic Service</b> .....	221
<b>F: Crop Insurance</b> .....	223
<b>G: The Metric System</b> .....	224



# List of Tables

## 1. Using Pesticides Safely

TABLE 1-1. Re-entry Periods for Selected Pesticides .....	4
TABLE 1-2. Pesticides Which Affect Cholinesterase Levels In Blood .....	4
TABLE 1-3. Safety Supply Companies in Ontario Providing Protective Clothing or Respiratory Devices .....	6

## 2. Pesticide Application

TABLE 2-1. Tree Row Volume Guidelines .....	13
TABLE 2-2. Water Volumes (dilute) for Special Pests .....	13
TABLE 2-3. Time Required to Pass a Number of Trees at Different Driving Speeds .....	13
TABLE 2-4. Spraying Time Per Hectare (Without Turning and Filling Time) .....	14

## 3. Soil Management and Fertilizer Use

TABLE 3-1. OMAFRA Accredited Soil Tests .....	16
TABLE 3-2. Soil pH at which Lime is Recommended for Ontario Crops .....	18
TABLE 3-3. Lime Requirements to Correct Soil Acidity based on Soil pH & Soil Buffer pH .....	19
TABLE 3-4. Example Calculation of the Fineness Rating of Limestone .....	19
TABLE 3-5. Average Amounts of Available Nutrients for Different Types of Manure .....	21
TABLE 3-6. Adjustment of Nitrogen Requirements where Crops Containing Legumes are Plowed Down .....	21
TABLE 3-7. Fertilizer Materials — Secondary and Micronutrients .....	23
TABLE 3-8. Fertilizer Materials — Primary Nutrients .....	23
TABLE 3-9. Soil Conductivity Reading Interpretation .....	24

## 4. Pest Management

TABLE 4-1. Control of Nematodes & Related Problems in Strawberry & Raspberry Plantings in Mineral Soils .....	29
TABLE 4-2. Control of Nematodes & Related Problems in Orchards on Mineral Soils .....	29
TABLE 4-3. Copper Products for Use on Fruit Crops in Ontario .....	35

## 5. Ground Cover Management

TABLE 5-1. Characteristics of Green Manure Crops and Cover Crops Grown in Ontario .....	39
---	----

## 7. Apples

TABLE 7-1. Nutrient Level Range (% Dry Weight) of Mid-Shoot Leaves .....	45
TABLE 7-2. Phosphorus & Potassium Soil Requirements Before Planting Apples .....	45
TABLE 7-3. Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Density and Tree Ages, Growing in Sod .....	47
TABLE 7-4. Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities .....	48
TABLE 7-5. Magnesium Foliar Sprays .....	48
TABLE 7-6. Calcium Foliar Sprays .....	50

## TABLE 7-7. Percentage Of Available Ascospores Discharged Under Various Environmental Conditions .....

TABLE 7-8. Relationship of Temperature and Moisture to Apple Scab Infection .....	60
TABLE 7-9. Relationship of Temperature, Hours of Wetting and Weeks after Full Bloom to Secondary Apple Scab Infection of Fruit .....	61
TABLE 7-10. Characteristics of Apple Scab Fungicides .....	62
TABLE 7-11. Effect of Fungicides on Apple Diseases .....	66
TABLE 7-12. AcceK® Rate .....	67
TABLE 7-13. Suggested Timing of Thinning (NAA) .....	69
TABLE 7-14. Suggested Rates for Chemical Thinning of Mature Apple Trees .....	71

## 8. Berry Crops

TABLE 8-1. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries .....	75
TABLE 8-2. Recommended Nitrogen (N) Rates For Strawberries .....	76
TABLE 8-3. Optimum Nutrient Level Range of Strawberry Leaves .....	76
TABLE 8-4. Recommended Nitrogen Rates for Raspberries .....	76
TABLE 8-5. Amount of Sulphur Required to Lower Soil pH (kg/ha) .....	78
TABLE 8-6. Nitrogen Requirements for Highbush Blueberries .....	78
TABLE 8-7. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves .....	79
TABLE 8-8. Disease Ratings on Selected Currant and Gooseberry Varieties .....	85
TABLE 8-9. Relative Resistance of Raspberry Varieties to Cane Infection by Fire Blight .....	89
TABLE 8-10. Field Resistance of Red Raspberry Varieties to Phytophthora Root Rot .....	90
TABLE 8-11. Effect of Fungicides on Strawberry Diseases .....	97
TABLE 8-12. Strawberry Variety Disease Ratings .....	98

## 9. Grapes

TABLE 9-1. Nutrient Level Range (% Dry Weight) of Grape Petioles .....	101
TABLE 9-2. Phosphorus & Potassium Soil Requirements Before Planting Grapes .....	102
TABLE 9-3. Magnesium Foliar Sprays .....	103
TABLE 9-4. Relative Disease Susceptibilities .....	111
TABLE 9-5. Effect of Fungicides on Grape Diseases .....	113

## **10. Tender Fruit (Stone Fruit and Pears)**

TABLE 10-1. Nutrient Level Range (% Dry Weight) of Mid-Shoot Leaves .....	115
TABLE 10-2. Phosphorus & Potassium Soil Requirements before Planting Tender Fruits.....	116
TABLE 10-3. Actual Nitrogen Rates Per Tree in Sod Culture.....	117
TABLE 10-4. Magnesium Foliar Sprays.....	117
TABLE 10-5. Chemical Families of Fungicides.....	121
TABLE 10-6. Effect and Activity of Fungicides on Stone Fruit Diseases .....	122
TABLE 10-7. Cherry Leaf Spot: Approximate Number of Hours Of Wetting Required For Conidial Infection by the Leaf Spot Fungus At Different Air Temperatures.....	127

## **12. Weed Management for Fruit Crops**

TABLE 12-1. Herbicide Groupings for Ontario.....	161
TABLE 12-2. Interval Before Rainfall (Post-Emergent Herbicides) .....	162
TABLE 12-3. Non-Selective Herbicides Available for Preplant Site Preparation.....	163
TABLE 12-4. Preplant Herbicide Weed Control Ratings .....	163
TABLE 12-5. Fruit Crop Herbicide Weed Control Ratings .....	200
TABLE 12-6. Strawberry Herbicide Weed Control Ratings .....	202
TABLE 12-7. Habitats and Herbicide Susceptibility of Common Aquatic Plants .....	205

## **13. Pesticide Tables**

TABLE 13-1. Pesticides Used on Fruit Crops in Ontario....	206
TABLE 13-2. Ontario Classification Schedules .....	212
TABLE 13-3. Number of Days from Last Spray to Harvest .....	214
TABLE 13-4. Pesticide Manufacturers/Agents.....	216

# 1. Using Pesticides Safely

Pesticides can be dangerous. Before opening any pesticide container, always read the entire label. Follow all directions to the letter and observe all stated precautions scrupulously.

## General Precautions with All Pesticides

1. Keep a record of the common names of all the pesticides you handle, especially those listed as hazardous in this publication. Other members of your family need to know about this list in case there is an accident.
2. Never smoke, chew tobacco, or eat while handling or applying pesticides. Do not carry tobacco or food in clothes worn while spraying. Change your clothes and wash before eating.
3. When handling and mixing pesticide concentrates, rinsing empty containers, or repairing leaks, wear a full set of protective clothing. This includes a waterproof cap, coveralls, impervious gloves and boots, and safety goggles. If you are using highly or extremely toxic pesticides or very dusty formulations, wear a respirator. If you are handling dusty formulations, wear a dust mask. If you are handling volatiles or gases, you must wear a respirator. If these gases are highly dangerous or you are handling them in an enclosed space, you may need a self-contained breathing apparatus. Make sure you follow the specific instructions on the pesticide label.
4. When you draw water from wells, ponds, streams, or other sources, use an anti-backflow device to prevent back-siphoning. Mix pesticide at least 50 m from wells, ponds, or streams. Triple or pressure rinse the empty container and add the rinse water to the tank. Only mix enough solution to do the spray job. When you have finished loading and mixing, wash down your gloves and boots with clean water before removing them.
5. During application, a tractor cab with charcoal filter gives adequate protection against exposure. Wear impervious gloves, boots, coveralls, and cap when tending

**Always read the label and follow the instructions on it.**

to stoppages. When using airblast and mist blowers, or in tractors without cabs, wear waterproof suits and caps and impervious gloves and boots. When applying fumigants in the field, have a respirator on hand in case you need to deal with equipment problems or in case inadequate sealing in the soil allows the fumigant to escape.

6. When the spray operation is done, bathe or shower to remove pesticide deposits on your skin. Do not handle anything in your home before you bathe.

For more information on pesticide use and safety, see the Best Management Practices book *Pesticide Storage, Handling and Application*, available from the Ontario Federation of Agriculture, tel: 416-485-3333, email: [research@ofa.on.ca](mailto:research@ofa.on.ca).

## Preventing Water Supply Contamination

Pesticides can contaminate well, pond, and surface water. It is an offence to contaminate surface waters with pesticides. Taking the following steps will help prevent contamination:

- Keep pesticide concentrates above the flood plain in locked storage.
- After emptying, triple or pressure rinse, crush, and dispose of containers.
- Return empty plastic or metal containers to a dealer who participates in the container recycling program. Empty bags, properly rinsed, may be burned or disposed of at a landfill site.
- Mix pesticide and water at least 50 m away from any water supply.

- Use buffer zones and berms to avoid contaminating surface water, wells, ponds, and streams.
- Do not use drinking water sources to fill spray equipment. If you fill your tank from a well, lake, river, or other surface water source, you must use an anti-back-flow device.
- Do not spray within 10 m of shallow wells or 5–10 m of other water supplies in ideal weather and farther away if there is any air movement. Stop spraying when wind velocity reaches 10 km/hr.

## If an Accident Occurs

1. Wash your gloves, boots, and respirator before removing them. Take off your clothing, including underclothes, immediately and wash contaminated skin thoroughly with soap and water. Soak clothes immediately and double launder them as soon as possible. If the spill was serious, place the clothes in a plastic bag and dispose of them in a safe manner. Wash your gloves, boots, and respirator again.

**If clothing becomes wet with a pesticide, remove clothing immediately, wash, and put on fresh clothes.**

2. If symptoms of illness occur during or shortly after handling a pesticide, go to a hospital. Take your list of common-name chemicals with you. (See *Emergency Procedures for Pesticide Poisoning* on the inside back cover.)
3. Clean up any pesticide spills immediately. In the case of minor spills, use dry soil or other absorbent material (such as kitty litter) to remove excess liquid. Sweep up powders and granulars. Contaminated soil and sweepings should be spread over a large area of bare soil to facilitate rapid degradation. Make sure you are adequately protected when cleaning up the spill.
4. For information on preventing spills see OMAFRA Factsheet *Ways to Avoid Pesticide Spills*, Order No. 96-025.
5. In the case of a major pesticide spill, you must notify the Ministry of the Environment, Spills Action Centre, 5775 Yonge St., Suite 1005, North York, Ontario, M2M 4J1. Telephone (416) 325-3000 or (800) 268-6060.

6. If a well becomes contaminated, follow the cleanup instructions in OMAFRA Factsheet *Pesticide Contamination of Farm Water Supplies*, Order No. 86-077.
7. See the inside back cover of this publication for *emergency procedures* and first aid in the event of pesticide poisoning.

## Relative Toxicity to Applicator

**Lethal Dose (LD<sub>50</sub>):** The dose that, when administered to test animals, will kill 50% of the test animals within a stated period.

**Acute Toxicity:** Immediate adverse effects from a single or short period of exposure to a substance via the oral, dermal, and/or inhalation routes.

**Chronic Toxicity:** Adverse effects resulting from repeated exposure to a substance over an extended period.

### High Acute Toxicity

*These pesticides are extremely dangerous if handled carelessly!* The acute oral LD<sub>50</sub> is less than 50 mg/kg of body weight, and the acute dermal LD<sub>50</sub> is less than 200 mg/kg body weight. These pesticides can be fatal if you ingest or absorb less than 0.1–3.0 mL (one drop to half a teaspoon). These pesticides are labeled with the skull and crossbones in a stop sign. *You must use a respirator and eye protection along with all other protective clothing when using these products:*

– azinphos–methyl	(Guthion, Sniper, APM)
– carbofuran	(Furadan)
– chlorophacinone	(Rozol)
– diphacinone	(Ramik Brown)
– endosulfan	(Endosulfan, Thiodan)
– methomyl	(Lannate)
– oxamyl	(Vydate)
– paraquat	(Gramoxone)
– parathion	(Parathion)
– zinc phosphate	(various mouse baits)

**Learn about the health hazards and toxic properties of the pesticide you are using.**

### Moderate Acute Toxicity

These pesticides are dangerous if handled carelessly. The acute oral LD<sub>50</sub> is 50–500 mg/kg of body weight, and the acute dermal LD<sub>50</sub> ranges from about 200–2,000 mg/kg

body weight. These pesticides can be fatal if you ingest or absorb as little as 3–30 mL ( $\frac{1}{2}$  tsp–2 tbsp). These pesticides are labeled with the skull and crossbones on a stop sign.

- 1,3-Dichloropropene (Telone IIB, Telone C-17-R, Vorlex Plus, Vorlex Plus CP)
- abamectin (Agri-Mek)
- amitraz (Mitac)
- cyhalothrin-lambda (Matador)
- cypermethrin (Cymbush, Ripcord)
- chlorpyrifos (Lorsban)
- deltamethrin (Decis)
- diazinon (Diazinon, Basudin)
- dimethoate (Cygon, Lagon)
- formetanate hydrochloride (Carzol)
- oxydemeton-methyl (Metasystox-R)
- phosalone (Zolone)
- phosmet (Imidan)
- pirimicarb (Pirimor)

**Wear a respirator when using these products**

### Low Acute Toxicity

These pesticides are not fatal unless deliberately ingested in amounts of over 30 mL (1 oz.). The acute oral LD<sub>50</sub> is greater than 500 mg/kg body weight, and the acute dermal LD<sub>50</sub> is greater than 2,000 mg/kg body weight.

Pesticides listed in this publication *and not listed in this section* have low acute toxicities. You should handle them with caution. You must wear protective clothing. You should wear safety goggles, and if using these products in a confined space, you should use a respirator

### Chronic Toxicity

It is not possible to assess chronic toxicity of a pesticide in the same way a LD<sub>50</sub> is used to determine acute toxicity. Instead, a number of tests performed on animals help predict whether a pesticide may cause long-term effects. Animals are examined for a wide variety of toxic effects such as the production of tumors or abnormalities. Using protective clothing and equipment will help reduce exposure and the risk of chronic effects.

### Entering Treated Areas

Workers may be poisoned if they enter fields without wearing protective equipment too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhaling pesticide vapours.

Table 1-1, *Re-entry Periods for Selected Pesticides*, shows a specific minimum interval that you must observe between applying pesticide and working in the crop without protective equipment. This is a partial list. Many product labels are being revised with specific re-entry periods recommended for specific tasks. Always refer to the label for the most correct information.

### Blood Tests for those Applying Pesticides

*Organophosphorus* and *carbamate* pesticides can inactivate serum and red blood cholinesterase levels. If cholinesterase activity falls below a critical level, poisoning can result. Symptoms include fatigue, dizziness, nausea, trembling, blurred vision, and difficulty breathing.

If you plan to use these pesticides, have your family doctor check your cholinesterase levels. *Start the blood tests before beginning to use any of these pesticides* — normal levels can vary considerably, making it difficult to assess the degree of suppression. In this publication, the insecticides of primary concern are found in Table 1-2, *Pesticides which Affect Cholinesterase Levels in Blood*.

## Protective Outdoor Clothing

### Why Use Personal Protection?

Pesticide formulations vary in toxicity from slightly to extremely poisonous. Exposure occurs once the pesticide is removed from the container. The toxicity of the pesticide and exposure to the user create a hazard. Both can be reduced, toxicity by dilution and exposure by protective clothing. You can reduce the hazards of spraying and thus the risk of poisoning. Wearing protective clothing reduces the risk.

### Reducing Exposure

- Exposure can be through skin, eyes, mouth, or nose.
- About 80%–85% of the exposure in most spray operations occurs during mixing and loading concentrate.
- Field application usually accounts for 15%–20% of the total pesticide exposure.
- Skin exposure is usually 90%–100% of the total exposure. Around 70% of this is by way of the hands and forearms and 30% involves the rest of the body.
- Inhalation (nose and mouth) exposure is normally 0.1%, but rises to 5%–10% with mist blowers and air blast sprayers.



**TABLE 1-1. Re-Entry Periods for Selected Pesticides**

Do not enter treated areas until the suggested time has passed		
Minimum interval before re-entry	Product trade name (common name)	Special comments
4 hours	Elevate (fenhexamid)	
12 hours	Aliette (fosetyl al)	
	Nustar (flusilazole)	
24 hours	Admire (imidocloprid)	
	Agri-Mek (abamectin)	
	Lannate (methomyl)	
	Matador (cyhalothrin-lambda)	
	Pirimor (pirimicarb)	
	Pyramite (pyridaben)	Re-entry after 4 hrs is permitted with protective clothing. See label
	Vydate (oxamyl)	
48 hours	APM (azinphos-methyl)	
	Bravo (chlorothalonil)	
	Furadan (carbofuran)	
	Guthion Solupak (azinphos-methyl)	Longer re-entry required for some tasks
	Sniper (azinphos-methyl)	
	Vanguard (cyprodinil)	
72 hours	Ronilan (vinclozolin)	See label for specific precautions
	Topas	Less for some activities/crops.
7 days	Parathion	
Other	Mitac (amitraz)	See label for specific precautions

### Protective clothing

- To reduce skin (dermal) exposure, wear impervious gloves. Always refer to the product label. Unless the label says otherwise, use neoprene or nitrile gloves.
- Always wear waterproof boots, along with coveralls, apron or spray suit, and waterproof cap.

**TABLE 1-2. Pesticides Which Affect Cholinesterase Levels In Blood**

APM	azinphos-methyl
Basudin	diazinon
Cygon	dimethoate
Diazinon	diazinon
Furadan	carbofuran
Guthion	azinphos-methyl
Imidan	phosmet
Lagon	dimethoate
Lannate	methomyl
Lorsban	chlorpyrifos
Parathion	parathion
Pirimor	pirimicarb
Sevin	carbaryl
Sniper	azinphos-methyl
Vydate	oxamyl
Zolone	phosalone

**Never apply pesticides without suitable protection.**

### Risk of Each Stage

Handling and mixing concentrate	very high risk
Rinsing empty containers	high risk
Applying outdoors	low to high risk
Applying indoors	medium to very high risk
Cleaning up, rinsing equipment	medium to high risk
Entering treated area within 48 hours	low to medium risk

- Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. It's easier for the pesticides to penetrate polyester than cotton. Disposable coveralls are polyethylene and may be laundered several times. Spray suits should be used in highly hazardous conditions such as with mist blowers and air blast machines.
- Protect your eyes with safety goggles when working with any pesticide concentrate.

### Respirators

- Use respirators when handling pesticides with labels that call for respiratory protection and carry the warning stop sign with skull and crossbones.

- Use respirators when spraying any pesticide rated as high toxicity or when applying any liquefied gas.
- Respirators are available as air purifiers or self-contained units and come in a wide range of shapes and sizes. Consult the label and your nearest safety supply company for advice. Make sure the cartridge or canister you use has a safety-approved sticker with the letters *NIOSH* (National Institute for Occupational Safety and Health) on it.

### ***Washing Protective Clothing and Equipment***

- To keep your protective clothing and equipment functional, clean it thoroughly.
- Never let children or pets come in contact with contaminated clothing or equipment.
- Launder clothing promptly. Wash and store other personal protection items.
- Rinse spray equipment and store it away to prevent children playing with it.
- If fabric clothing is saturated with the concentrate of a highly toxic pesticide, throw it out. Wear nitrile or neoprene gloves when handling severely contaminated clothing. Remove the clothing carefully and immediately put it in a plastic bag and dispose of it in a safe manner.

*For a normal spray operation, follow these guidelines, preferably twice a day, but at least at the end of the work day.*

- Rinse clothing outdoors.
- Soak and wash clothing separately.
- Soak clothes, with detergent, in a container such as a large bucket or tub; or use the pre-wash cycle of an automatic washer, with detergent. Pre-wash, solvent-based products work on EC formulations.
- Wash only a few garments at a time.
- Use heavy-duty liquid detergents.
- Use hot water, the highest water level, and a hot super-wash cycle.
- Do two complete wash cycles, each with a double rinse.
- After washing, run another wash cycle with detergent and no clothing to decontaminate the washing machine.

- Hang the clothes to dry, outside if possible, to avoid a potential buildup of pesticide residue in the dryer.

### ***Rubber, Vinyl, or Plastic Boots and Gloves***

- To avoid getting pesticide on your hands, wash the outside of your boots and gloves with detergent and water before taking them off.
- After removing boots and gloves, wash them inside and out with detergent and water, rinse them thoroughly, and dry them in a well-ventilated area.

### ***Chemical-Resistant Clothing, Goggles, and Face Masks***

- Wash plastic or rubber clothing and equipment with detergent and water.
- Rinse thoroughly and dry in a well-ventilated area.

### ***Respirators***

- Discard all cartridges, canisters, and filter pads when breathing becomes difficult, when you notice a pesticide odour, or at the interval set by the manufacturer. Make a note of the date the cartridge is first used.
- Remove cartridges and filter pads from the face piece and store them in clean, sealed plastic bags.
- Never use alcohol or other solvents for cleaning, as they will damage the rubber and plastic.
- Wash the face piece in detergent and water, rinse it thoroughly, and dry it in a well-ventilated area.
- Consult Table 1-3, *Safety Supply Companies*, for the safety supply house of your choice for help in selecting your protective clothing.

## **Protection for Grain Storage and Enclosed Areas**

### ***Canister Gas Masks***

Canister gas masks are effective for protection against certain harmful gases, vapours, and particulate matter. They are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

### ***Self-Contained Breathing Apparatus***

Air purifying apparatuses do not work in confined spaces where gas concentrations are unusually high. The lack of oxygen can prove fatal. Under these conditions, you need an air supply provided by a self-contained breathing apparatus (e.g., *Scott Air Pack*).



**TABLE 1-3. Safety Supply Companies in Ontario Providing Protective Clothing or Respiratory Devices**

E.A.R., AOSafety, Peltor, Eastern	Aearo Canada Ltd. 7115 Tomken Road Mississauga, Ontario L5S 1X7	905-795-0700	
H.S. Cover Survivair	Levitt-Safety Ltd., 2872 Bristol Circle Oakville, L6H 5T5	905-829-3299 888-453-8488	Branches: Kitchener, London, Oakville, Ottawa, Sarnia, Stoney Creek, Sudbury, Thunder Bay
Kasco Helmets	The St. George Co. P.O. Box 430 20 Consolidated Drive Paris, N3L 3T5	519-442-2046 800-461-4299	www.thestgeorgeco.com
Mine Safety Appliances	MSA Canada Inc. 148 Norfinch Drive North York, M3N 1X8,	416-667-9400 800-267-0672	
3M Canada Inc. Occupational and Environmental Safety Division	A wide range of distributors contact P.O. Box 5757 London, N6A 4T1	519-451-2500	
North Safety Products Ltd.	26 Dansk Court Toronto, M9W 5V8	416-675-2810 800-268-6925	
Racal Airstream, Scott, Willson	Acklands-Grainger Inc. 90 West Beaver Creek Rd. Richmond Hill, L4B 1E7	800-387-5744	Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay, Windsor
Medical Safety First Aid	Kit Care Corp. 91 Kelfield St., Unit 6 Rexdale, M9W 5A4	416-243-3030	Branches: Kitchener, London, Orillia, Ottawa, St. Catharines, Stoney Creek

Many of these companies also have dealer outlets. For details contact the supply company

Using substances that produce *hydrogen cyanide*, *methyl bromide*, *chloropicrin*, or *phosphine* can produce high gas concentrations and oxygen deficiency, as can smoke generators, foggers using highly toxic pesticides, and some volatile sprays.

### Other Protective Clothing

Wear other protective clothing in keeping with requirements listed on the pesticide's label.

### Working Conditions

Use canister gas masks when the surrounding air contains low concentrations of toxic gases, vapours, or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in this manner usually have moderate to low toxicity.

You must use a self-contained breathing apparatus (e.g., *Scott Air Pack*) when applying highly toxic pesticides. These can produce high concentrations of toxic gases, vapours, or particulate matter, and a lack of oxygen, especially in an enclosed space (e.g., fumigating grain). Contact your safety supply company for their recommendation.

### Space Fumigants and Insecticide Smokes

- When using fumigants or insecticide smoke generators, wear protective clothing to prevent skin and inhalation exposure.
- During and after treatment, lock the building and post warning signs.
- Follow instructions on the product label regarding aeration of treated buildings, warehouses, grain storage bins, or areas before letting anyone enter.

### Using Fumigants

- An agriculturalist using methyl bromide plus chloropicrin or aluminum phosphide to fumigate greenhouses, vaults, warehouses, and grain storage must obtain a permit issued under the *Pesticides Act*. To apply for a permit, contact the local pesticide officer with the Ministry of the Environment. You must obtain a permit every time you use these treatments.
- Remove livestock and poultry that are in the same building, especially if they are under the grain bin.

- As a safety precaution, have someone else who is wearing personal protective equipment help with the fumigation.
- Always consult the product label.
- When handling *methyl bromide*, do not wear gloves because these will trap gas next to the skin. You must wear a full-face respirator with organic vapour canister or a positive-pressure breathing apparatus.
- When handling *aluminum phosphide*, use cotton gloves and wear a full-face mask respirator with an acid gas canister.
- For more information, obtain the publications *Methyl Bromide Structure Fumigation Procedures* and *Aluminum Phosphide Structure Fumigation Procedures* from the Ministry of the Environment.

**You must be licensed and obtain a permit before using certain fumigants.**

## Storing Pesticides

- The Ontario *Pesticides Act* and *Regulation 914* require that all pesticides be kept out of the reach of children, irresponsible persons, pets, and livestock. They should be stored in a locked facility away from food and feed.
- Herbicides should be stored separately from other pesticides to avoid contamination.
- Always store pesticides in their original containers and keep them tightly closed.
- Never put pesticides in unmarked containers.
- In areas where flooding has been frequent, you must store fertilizers and pesticides above the known high water mark. Contamination of water by these chemicals has led to serious health problems for humans and domestic animals as well as fish and wildlife.
- See also the OMAFRA Factsheet *Pesticide Handling Facilities*, Order No. 94-037.

## Schedule 1, 2 and 5 Pesticides

- Schedule 1, 2 and 5 pesticides must be stored in a facility that is ventilated to the outside.
- A sign that says "CHEMICAL STORAGE WARNING—AUTHORIZED PERSONNEL ONLY" in block capitals must be fixed to the outside of each entrance.
- Only the certified agriculturalist or someone under that person's supervision may enter the storage facility.

## Disposal of Containers and Contaminated Materials

- All paper or cardboard pesticide containers, paper packaging material, or other paper material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or outdoor public areas. Plastic material must not be burned.
- Unrinsed containers can contain as much as three per cent of the original formulation. If this amount of toxic pesticide is discarded with the container, it could be dangerous to other people handling it or to the environment (for example, your water supply). Failure to rinse is also wasteful. Use that 3% for the reason you bought it—to control the pest!
- Rinse all metal, plastic, or glass containers three times with water and add the washings to the spray tank. Alternatively, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic container and rinse the residue directly into the spray tank. This procedure takes less than a minute. Return the rinsed containers for recycling to any dealer cooperating in the pesticide container collection and recycling program.
- Dispose of any unwanted or contaminated pesticide materials through *Laidlaw Environmental Management* (Telephone: 519-451-6630), or contact the appropriate registrant to develop an alternative method acceptable to the Director under the *Pesticides Act* (416-323-5095).

**Rinse containers properly and apply the rinse water to the crop which was sprayed.**

## 2. Pesticide Application

### Spray Application Technology

Always apply pesticides correctly. Incorrect application can waste pesticide, compromise control, damage crops (possibly your neighbours) and contaminate the environment. New equipment and control systems can make pesticide application simple and precise.

### New Technologies

Equipment manufacturers now work closely with the crop protection industry to refine application systems.

- Computerized sprayer controllers and ground speed radar are now available. These provide accurate application monitoring and control.
- Upcoming developments in application technology include closed injection systems that separate the pesticide concentrate from the water carrier, and hooded air assists and electrostatic methods.

### Sprayers for Home Use

Use a 9–14 L knapsack or compressed air garden sprayer.

- A nozzle tip producing coarse spray minimizes spray drift.
- Keep spray pressure low — it is easy to reach pressures of up to 700 kPa. High pressures produce smaller spray droplets that, in light winds, can drift to susceptible garden plants.
- Use a separate sprayer for herbicides.

### Field Sprayers

Use *boom-type sprayers* for field pesticide applications. These sprayers apply pesticides evenly across the width of the boom. To spray fields effectively, always maintain:

- uniform spray pressure
- constant forward speed
- stable boom height (to assure uniform overlap of the nozzle tip patterns)
- appropriate application rates (L/ha) depending on the pesticide used.

### Air Blast or Mist Sprayers

*Never use air blast or mist sprayers to apply herbicides.* They can cause herbicidal damage far from the target treatment area.

### Wiper Applicators for Selective Weed Control

*Wiper applicators* (e.g., rope-wick, roller applicator) are commonly used with glyphosate (Roundup). Check product labels for information about using this technique with other herbicides. Labels list the crops for which wiper application is registered. To use wiper applicators:

- follow manufacturers' directions
- contact enough of the target weed to get herbicidal effectiveness
- keep the applicator above desirable vegetation to avoid crop injury
- maintain a vehicle speed of 4–10 km/hr
- make a second pass, especially in heavy weed infestations or if using a higher vehicle speed
- avoid contact with sucker growth in orchards, vineyards and shelter belts

### Equipment Use and Care

#### Spraying Speeds

Uniform application rates require a constant forward speed whenever spray nozzles deliver liquid. If a tractor's driving wheels slip on the soil surface, the tractor's speedometer won't indicate a change in forward speed.

- To monitor forward speed despite wheel slippage on hills, use an *independent speedometer* with a *ground driven wheel*.
- Install spray monitors and other electronic rate controllers. These automatically correct for tractor speed variations to maintain a constant application rate.

#### Using Water Correctly

- Mix pesticides with clean water that does not contain debris, sand or mud.

- Never let the water intake screen rest on a pond bottom when filling a sprayer.
- The water intake line near the screen must, by law, have a check valve or backflow device. This prevents water-source contamination when the pump is shut off.
- Do not use a tank-refilling nozzle, volume-booster nozzle, or injection pump when refilling sprayer tanks from ponds or streams. These tank-refilling aids may contaminate the water source.
- When using a farm water supply, install a frost-free water hydrant outside the building. Place a backflow valve/siphon on the discharge end of the hydrant.

### Agitation

You must return spray solution to the sprayer tank to provide hydraulic agitation within the tank.

- To be effective, the return or bypass line from the pressure regulator must deliver liquid to the tank bottom.
- Return 2–14 L/min. to the tank when applying *chemical formulations in solution*.
- Return 14–27 L/min. for each 450 L of tank capacity when spraying *wettable powders*. The appropriate rate depends on the wettable powder concentration and size of the tank. A dedicated line from the pressure side of the pump (not the pressure regulator) to the tank must be used to carry the liquid necessary for hydraulic agitation. Always use a *venturi jet* or *sparge tube*. Sparge tubes need more water than venturis to provide the same agitation. You can reduce the flow rate if the sprayer tank has a mechanical agitator.

### Preparing a Wettable Powder and Oil or Emulsifiable Concentrate Mix

To prepare a tank mix of wettable powder and an oil or emulsifiable concentrate, follow these steps unless the product label states differently:

1. Fill the sprayer tank with water to the half full mark.
2. Start the agitator.
3. Add a premixed slurry of wettable powder and water.
4. Agitate for 2 min. before adding more water.
5. Add the oil or emulsifiable concentrate last.

6. Do not over-agitate the mixture. It may become a grease-like mass that settles to the tank bottom. Over agitation may also cause the mixture to foam excessively.
7. After any break from spraying, agitate the tank thoroughly before resuming.
8. To prevent oil buildup in the sprayer, empty the tank completely before refilling.
9. Clean the tank and sprayer with a detergent or solvent immediately after use, then flush thoroughly with clean water.

### Using Products in Water Soluble Packaging

To simplify disposal of empty pesticide packages, the industry has re-introduced a soluble package that dissolves in the tank of the sprayer. Water soluble packaging, such as *Clearpak*, *Instapak*, *Solubag*, *Solupak*, *Solupouch* or *Toss "N" Go*, will become more common for dry flowable and wettable powder formulations of pesticides.

In most cases, the water-soluble packaging material is PVA (polyvinyl alcohol). This material dissolves completely when added, according to instructions, to the water in the sprayer tank.

You must follow these handling, mixing and compatibility precautions and instructions.

### Handling

- Do not allow water-soluble pouches to become wet before adding to the sprayer tank.
- Do not handle the water-soluble pouches with wet hands or wet gloves.
- Do not remove water-soluble pouches from the over-wrap (outer package), except when adding directly to the sprayer tank.
- Always reseal the outer package to protect the remaining pouches from moisture.

### Mixing

- Add the water-soluble pouches to the tank after the sprayer tank is one-quarter full of water and the agitator is running.
- Depending on the water temperature and the degree of agitation, these pouches should dissolve completely within 5 mins.



- As the tank continues to fill, add any other compatible pesticides.

### Compatibility

- Do not add a pesticide incompatible with the PVA packaging material.
- The PVA material is not soluble with summer type oils (e.g., Superior Oil), or EC formulations containing mineral or vegetable oil products.
- Do not combine with the pouches any material containing boron (e.g. *Solubor*), chelated micronutrients or water-soluble fertilizers. The combination of these chemicals with PVA film is likely to cause a sticky, insoluble substance in the tank.
- After applying boron, chelated micronutrients or water-soluble fertilizers, completely empty and rinse the spray tank before using any product packaged in PVA.

Read all labels and instructions carefully; for more details contact your farm chemical dealer.

### Pumps

Sprayer pumps must supply adequate capacity, pressure, volume and agitation for the task at hand.

- Use *piston*, *diaphragm*, or *centrifugal* pumps for wettable powder suspensions.
- Use any of the above plus *roller pumps* for liquid herbicide applications.
- Pumps used for wettable powders and flowable formulations need abrasion-resistant housings.
- Follow the manufacturer's care and storage instructions for optimum pump performance.
- Running a spray pump without water may cause premature wear or damage.

### Nozzles

Accurate spray application requires high quality nozzle tips. They must emit a uniform spray pattern at an expected rate. You can purchase *machined orifice* and *moulded orifice* tips made from materials ranging from *brass*, *stainless steel*, and *hardened stainless steel* to non-metals such as *plastics/polymers* and *ceramics*. Choose an appropriate tip using the guidelines below and examine the tip's spray pattern before each use. When using boom-type sprayers

maintain a stable boom height to assure uniform spray pattern overlap to prevent missed areas.

- All pesticide formulations cause orifice wear, especially *wettable powders*. Replace nozzle tips when they deliver 10% more spray than they did when new.
- Worn nozzle tips spray unevenly and can produce streaks across a field by delivering too much herbicide to a given area.
- Flushing water through the boom and nozzles does not remove pesticide residue buildup on the nozzles. Always clean nozzle tips and screens thoroughly. Remove them from the nozzle body and wash with soap, water and a bristle brush.

### Flat-Fan Nozzle Tips

- Flat-fan nozzle tips work well with boom-type herbicide sprayers. Flat-fan tips may be color-coded for size (i.e., output). Some colour-coded tips have stainless steel, ceramic, or plastic/polymer inserts, or are used for specialized applications. Always read manufacturers' labels carefully.
- Set spacings, boom height and pressure as per manufacturer's recommendations. If not otherwise stated, maintain spray pressure at 275 kPa for standard elliptical-orifice flat-fan tips. (Some flat-fan nozzle tips operate at a reduced pressure of approximately 140 kPa. These tips reduce risk of drift.)
- Maintain a full overlap spray pattern by using *110-series* of flat-fan nozzle tips (instead of *80-series* tips) with the same 51 cm spacing and the same height as the *80-series* tips. This reduces misses should the boom bounce while traversing rough ground.
- You may obtain special "even-spray" nozzle tips for herbicide band applications. The nozzle's tip height, spray angle and orientation to the travelling direction combine to control the sprayed bandwidth. Follow manufacturers' directions closely.

### Flooding-Fan Nozzle Tips

- Flooding-fan nozzle tips have a wide spray angle. They can be used closer to the ground, and at lower pressures, than flat-fan tips. This reduces drift.
- Flooding fan nozzle tips come in brass, plastic/polymers and stainless steel. They cover roughly twice the width as flat-fan nozzle tips. However, they tend to distribute herbicides less evenly than flat-fan tips.

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D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL**

### Broadcast Nozzle Tips

- Broadcast nozzle tips cover a very wide swath.
- Use broadcast nozzle tips for lanes and fencerows where you don't need a uniform spray pattern.
- Never use a broadcast-type nozzle tip near a susceptible crop. The spray may drift severely with even a light breeze.

### Full and Hollow Cone Nozzle Tips

Full or hollow cone nozzle tips are used primarily for high pressure application of insecticides and fungicides for horticultural crops. They can also be used to spray the soil surface when the herbicide is incorporated into the soil with a disk harrow, cultivator or similar tillage implement.

### Nozzle Screens

You may obtain ball-check and plain nozzle screens. Ball-check screens use a diaphragm check valve on each nozzle to minimize dripping from the boom.

- Never mix screen types in a spray boom, since different screen types produce different flow rates through the nozzle.
- Flushing water through the boom and nozzles does not remove pesticide residue buildup on the nozzle screens. Always clean nozzle screens thoroughly. Remove them from the nozzle body and wash with soap, water and a bristle brush.

### Environmental Issues when Cleaning

- Before cleaning the sprayer, you must safely dispose of any surplus tank mix. The *Grower Pesticide Safety Course* suggests diluting the remaining spray solution at least 1:10 with water. You can safely apply this diluted solution to the previously treated area if you don't exceed the maximum application rate on the product label.
- Equipment used with 2,4-D, MCPA or related *phenoxy* herbicides must never be used to spray other types of solutions on 2,4-D-susceptible crops or garden plants. Never store these products near greenhouses or other areas with susceptible crops.
- The wash water contains pesticides. Never allow wash water into a well, lake, pond, river or other water source.

### Cleaning the Sprayer

- Clean sprayers immediately after spraying each day and whenever you change chemicals. Delaying even overnight allows persistent deposits to form.
- Don't neglect any sprayer parts. Clean the spray tank, booms, hoses, nozzles, tips, screens, filters, strainers and pumps. Be sure to remove every trace of pesticide.
- Cleaning techniques depend on the pesticide applied. Many pesticides list tank-cleaning information on the label — always follow these instructions. If necessary, contact the pesticide manufacturer to learn the best cleaning methods for a product. If you can't get specific cleaning instructions, use a strong detergent or alkaline cleaner. Then rise thoroughly.
- Surfactants may remove pesticide residues from spray equipment. Be sure tanks containing herbicide/surfactant (e.g. Agral 90) mixtures are scrupulously clean. Otherwise, the mixture may remove residues from the spray equipment, adversely affecting the crop.

## Sprayer Calibration

### Boom Sprayer Calibration

#### Field Boom Type Sprayer Calibration

(Determining application rates in L/ha)

There are many ways of determining the number of litres of spray material that are being applied to 1 ha of land — or calibrating a sprayer.

#### Instructions

1. Measure the time.
  - Place 2 stakes 50 m apart in the field.
  - Select the gear and throttle setting (rpm) at which you plan to spray. Fill the sprayer half full of water.
  - Drive the distance between the stakes 3 times, timing each pass. Each time, make sure the tractor is at the desired speed as you pass the first stake. Keep driving at this speed until you pass the second stake.
  - Take the average time of the 3 passes.
2. Measure the average nozzle output.
  - Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
  - Adjust the pressure regulator to the desired working pressure with full flow to the boom.





### **Broadcast Nozzle Tips**

- Broadcast nozzle tips cover a very wide swath.
- Use broadcast nozzle tips for lanes and fencerows where you don't need a uniform spray pattern.
- Never use a broadcast-type nozzle tip near a susceptible crop. The spray may drift severely with even a light breeze.

### **Full and Hollow Cone Nozzle Tips**

Full or hollow cone nozzle tips are used primarily for high pressure application of insecticides and fungicides for horticultural crops. They can also be used to spray the soil surface when the herbicide is incorporated into the soil with a disk harrow, cultivator or similar tillage implement.

### **Nozzle Screens**

You may obtain ball-check and plain nozzle screens. Ball-check screens use a diaphragm check valve on each nozzle to minimize dripping from the boom.

- Never mix screen types in a spray boom, since different screen types produce different flow rates through the nozzle.
- Flushing water through the boom and nozzles does not remove pesticide residue buildup on the nozzle screens. Always clean nozzle screens thoroughly. Remove them from the nozzle body and wash with soap, water and a bristle brush.

### **Environmental Issues when Cleaning**

- Before cleaning the sprayer, you must safely dispose of any surplus tank mix. The *Grower Pesticide Safety Course* suggests diluting the remaining spray solution at least 1:10 with water. You can safely apply this diluted solution to the previously treated area if you don't exceed the maximum application rate on the product label.
- Equipment used with 2,4-D, MCPA or related *phenoxy* herbicides must never be used to spray other types of solutions on 2,4-D-susceptible crops or garden plants. Never store these products near greenhouses or other areas with susceptible crops.
- The wash water contains pesticides. Never allow wash water into a well, lake, pond, river or other water source.

### **Cleaning the Sprayer**

- Clean sprayers immediately after spraying each day and whenever you change chemicals. Delaying even overnight allows persistent deposits to form.
- Don't neglect any sprayer parts. Clean the spray tank, booms, hoses, nozzles, tips, screens, filters, strainers and pumps. Be sure to remove every trace of pesticide.
- Cleaning techniques depend on the pesticide applied. Many pesticides list tank-cleaning information on the label — always follow these instructions. If necessary, contact the pesticide manufacturer to learn the best cleaning methods for a product. If you can't get specific cleaning instructions, use a strong detergent or alkaline cleaner. Then rise thoroughly.
- *Surfactants* may remove pesticide residues from spray equipment. Be sure tanks containing herbicide/surfactant (e.g. *Agral 90*) mixtures are scrupulously clean. Otherwise, the mixture may remove residues from the spray equipment, adversely affecting the crop.

## **Sprayer Calibration**

### **Boom Sprayer Calibration**

#### **Field Boom Type Sprayer Calibration**

(Determining application rates in L/ha)

There are many ways of determining the number of litres of spray material that are being applied to 1 ha of land — or calibrating a sprayer.

#### **Instructions**

1. Measure the time.
  - Place 2 stakes 50 m apart in the field.
  - Select the gear and throttle setting (rpm) at which you plan to spray. Fill the sprayer half full of water.
  - Drive the distance between the stakes 3 times, timing each pass. Each time, make sure the tractor is at the desired speed as you pass the first stake. Keep driving at this speed until you pass the second stake.
  - Take the average time of the 3 passes.
2. Measure the average nozzle output.
  - Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
  - Adjust the pressure regulator to the desired working pressure with full flow to the boom.

- Collect the output from each nozzle for the average length of time needed to travel the 50 m in the test run.
- Enter the nozzle outputs into the chart below.
- If any nozzle is more than 5% above or below the average output, it should be cleaned or replaced.

3. Measure the nozzle spacing in metres.

4. Use the following formula to determine the sprayer output:

$$\text{Sprayer Output (Litres/Hectare)} = \frac{\text{Average Nozzle Output (mL)}}{\text{Nozzle Spacing (meters)}} \times 0.2$$

5. Calculate the actual area sprayed after each tank of spray solution is applied. Re-check the actual sprayer calibration after each tank of spray is applied by dividing the volume sprayed by the actual area sprayed. The nature of some products may slightly alter the calibration from that of clean water.

6. Growers who prefer to measure in litres/acre or gallons/acre, can use the following conversion guide.

#### Conversion factors:

$$\text{L/ha} \times 0.4 = \text{L/acre}$$

$$\text{L/ha} \times 0.11 = \text{U.S. gal/acre}$$

$$\text{L/ha} \times 0.09 = \text{Imp. gal/acre}$$

#### Sample Calculation:

Time to travel 50 metres (164 ft): 24.5 seconds

Liquid collected/nozzle for 24.5 sec: 525 mL

Nozzle spacing on the boom: 0.5 metres

$$\text{Application Rate} = \frac{525 \text{ mL}}{0.5 \text{ m}} \times 0.2 = 210 \text{ L/ha}$$

#### Conversions:

$$210 \text{ L/ha} \times 0.4 = 84 \text{ L/acre}$$

$$210 \text{ L/ha} \times 0.11 = 23 \text{ U.S. gal/acre}$$

$$210 \text{ L/ha} \times 0.09 = 18.9 \text{ Imp. gal/acre.}$$

#### Band Spraying

If the sprayer has 10 nozzles and each nozzle covers a 36 cm (0.36 m) band, the total width of the spray patterns (swath width) is: 10 x 0.36 or 3.6 m.

#### Notes:

- Sprayer calibration bottles or kits are available from a number of suppliers. For further information contact the manufacturers of sprayers, sprayer parts or herbicides.
- For banded spray applications, measure the width of the spray band (at the soil surface or surface of the crop canopy) and enter this value into the formula instead of the "nozzle spacing". Where band spraying, the acreage sprayed is not the same as the crop acreage. Unless otherwise stated, the herbicide rates referred to in most herbicide publications and labels refer to the actual area sprayed.

#### Guide for Spraying Tree Fruits

- The sprayer must be large enough to cover the orchard in the time available and under adverse conditions.
- Equipment must be in top condition.
- Trees must be pruned so the spray penetrates easily.
- Weather conditions must be monitored, and the orchard checked routinely for disease, insect pest numbers and stages, so that spray timing is accurate.
- The rate of pesticide and the volume of water required varies depending upon the individual situation. The rates in the spray calendar are based on spraying trees 4.5–5.5 m high. Trees larger or smaller may require more or less pesticide. See Table 2-1, *Tree Row Volume Guidelines*. The volume of water required to spray the tree varies due to application equipment, tree size and target pest. The original *dilute* rate was based on spraying a standard-sized tree to runoff. For trees 4.5–5.5 m, this is now considered to be 3,000 L/ha. This volume can be adjusted up or down depending on tree size. See Table 2-2, *Water Volumes (Dilute) for Special Pests*.
- Many growers successfully adjust rate of pesticide applied by changing the volume of spray mixture applied — either by turning off certain nozzles, or by changing driving speed. This allows growers to spray different orchard blocks, of different tree sizes, while maintaining the same amount of chemical in each full tank of water.
- Both low-volume applications and low rates of chemical have resulted in increased populations of scale insects, mites and woolly aphid, especially in tree tops.

Note: Companies are not liable for pest control failures due to use of rates below those recommended on their labels.

**TABLE 2-1. Tree Row Volume Guidelines**

Tree Height	Pesticide/ha	Water/ha for Dilute Spraying
6 m and over	1 1/3 X recommended rate	4000 L
4.5-5.5 m	full recommended rate	3000 L
2.5-3 m	2/3 X recommended rate	2000 L

Table 2-1 recognizes that effective coverage of smaller tree canopies can be achieved when using a lower volume of spray solution. In general, the method of calculating spray volume requirements for tree canopies is referred to as Tree Row Volume. For further explanation and instruction, on Tree Row Volume, refer to OMAFRA Factsheet, *Guide for Spraying Fruit Trees*, Order No. 93-121.

For oil sprays, use enough spray liquid to soak the bark completely. When spraying streptomycin for fire blight, higher volumes are also required for maximum absorption of material. Suggested volumes are listed in Table 2-2 below.

**TABLE 2-2. Water Volumes (Dilute) for Special Pests**

Trees 6 m and over	4500 L water/ha
Trees 4.5 - 5.5 m	4000 L water/ha
Trees 2.5 - 3.0 m	3500 L water/ha

### Airblast Sprayer Calibration

Refer to Table 2-4, *Spraying Time Per Hectare* on driving time per hectare. Proceed through the following 7 steps.

1. Check tractor speed. (see Table 2-3, *Time Required to Pass a Number of Trees at Different Driving Speeds*)
2. Make a sprayer-tank measuring stick marked off in units of 50 L.
3. From Table 2-4 find the number of minutes needed to spray a hectare at the speed recommended for your sprayer.
4. Decide how many litres of liquid per hectare you wish to use (considering time available, size of sprayer, size of trees, and time of day spraying will be done). The use of tree row volume can help determine the spray volume required.
5. Find the sprayer output required:  

$$\frac{\text{litres per hectare}}{\text{time per hectare}} = \text{litres per minute (for all nozzles)}$$
6. Divide the output by the number of nozzles:  

$$\frac{\text{litres per minute}}{\text{number of nozzles}} = \text{litres per minute (per nozzle)}$$
7. From manufacturer's nozzle charts, find a nozzle to give this output. Then choose nozzles with smaller outputs for top and bottom positions and larger ones for the upper third of each side. When added, the total output should be close to the value shown in step 5 (L/min.). For small trees, block off 1 or 2 of the top nozzles and shut off between trees to prevent waste of spray.

### Pesticide Injury to Crops

Although insecticides and fungicides have been selected and formulated to avoid plant injury, damage can still occur under some conditions. Please observe the following precautions.

**TABLE 2-3. Time Required to Pass a Number of Trees at Different Driving Speeds**

Tractor Speed (km/hr)	In the Row Tree Spacings (Meters)							
	1.6	3.1	4.6	6.1	7.6	9.1	10.7	12.2
	Time (seconds) to pass 10 trees							
2.4	23	45	68	91	114	136	159	182
3.2	18	34	51	68	85	102	119	136
4.0	14	27	40	54	68	82	95	109
4.8	12	23	34	45	58	70	82	94
5.6	10	19	27	39	49	58	68	78
6.4	9	17	26	34	43	51	60	68

TABLE 2-4. Spraying Time Per Hectare (Without Turning and Filling Time)

Distance between rows (metres)	Tractor Speeds (km/hr)						
	1.6	2.4	3.2	4.0	4.8	5.6	6.4
	Time (in minutes) to Drive One Hectare						
3.1	125	82.5	62.5	50	41.25	35	31
4.6	82.5	55	41.25	33	27.5	23.5	20.5
6.1	62.5	41.25	31	25	20.5	17.75	15.5
7.6	50	33	25	20	16.5	14	12.5
9.1	41.25	27.5	20.5	16.5	13.75	11.75	10.25
10.7	35.25	23.5	17.75	14	11.75	10	8.75
12.2	31	20.5	15.5	12.5	10.25	9.5	7.75

- Apply sprays when the drying condition is fast. Some chemicals break down to components that are injurious to plant tissues if permitted to stay wet.
- Apply sprays when temperature is below 27°C. The spray deposits serve as a lens and concentrate the heat on the plant tissues.
- Be particularly careful when plants have been under growth stress such as prolonged periods of drought, excessive cloud cover, extremely low or high temperatures.
- Apply sprays soon after mixing. Undesired chemical change may take place with some chemicals if the sprays remain in the tank for prolonged lengths of time (e.g. overnight). In other cases, the chemicals may settle out and clog the lines.

## Application by Airplane or Helicopter

Aerial applicators must be licensed by the Ontario Ministry of the Environment to apply pesticides. In addition, they need permits from the Ontario Ministry of the Environment to apply Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. Ministry personnel will inspect the area to ensure the application is done safely.

It is an offence under the federal *Pest Control Product Act* to use a control product under unsafe conditions. Precautions must be heeded at all times to prevent drift. Take extra precautions when using insecticides applied by air, especially those known to be toxic to honey bees, such as Sevin (carbaryl).

Do not apply pesticides when the wind is blowing. Even on the calmest day, some drift occurs. To keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the contract specifies the product to be used and its rate of application

## Pesticide Drift

Pesticide drift can leave residues on adjacent crops, be a hazard to nearby people and livestock, and reduce the amount of material in the target area so that it is ineffective. When you apply pesticides, make every effort to minimize or prevent pesticide spray drift by:

- correctly calibrating and maintaining spray equipment
- operating the equipment correctly
- being aware of the toxicity of the pesticide being used
- being aware of weather conditions.

Growers are responsible for any material discharged from their sprayers no matter where it is found. This includes liability for adverse affects such as damage to crops or to ornamental plants and illegal or unacceptable residue on neighbours' crops or property. You could also be responsible for injury resulting from car accidents caused by windows smeared by spray drift or allergic or asthmatic reactions of bystanders, even if they are not on your property. Take all precautions necessary to prevent drift off site that might implicate you in any damaging action.

For more information consult the Best Management Practices books, *Pesticide Storage, Handling and Application* and *Integrated Pest Management*, available from the Ontario Federation of Agriculture, tel: 416 485-3333, email: [research@ofa.on.ca](mailto:research@ofa.on.ca).



# 3. Soil Management and Fertilizer Use

For a complete guide to soil fertility, consult OMAFRA Publication 611, *Soil Fertility Handbook*.

## Soil Testing

Ontario currently uses almost 690,000 tonnes of fertilizer annually. High yields can only be produced efficiently when fertilizer use is related to:

- fertility level of the soil
- additions of nutrients from manure
- crop residues
- other organic sources.

At one extreme, on very low fertility soils, it can be profitable to add as much or more nitrogen, phosphorus or potassium to the soil as a crop removes. But on high fertility soils, or following heavy application of manures, fertilizer may not be profitable, and occasionally may reduce yields.

### Why Soil Test?

Soil tests accredited by OMAFRA are the most accurate tool available to Ontario farmers to determine the amount of phosphorus, potassium and magnesium fertilizers, and lime to apply for crop production. To amend the soil properly, always take a soil test well in advance of establishing perennial fruit crops. Always ask for OMAFRA accredited soil tests.

## Other Methods of Assessing Nutrient Needs

*Plant tissue analysis* is the main tool used for tree fruits and several berry crops. Plant analysis can provide additional information supporting the soil test for field and vegetable crops.

In some cases, *nutrient deficiency symptoms* on crop leaves help assess deficiencies. However, this method is not always appropriate for determining potassium and phosphorus levels, because yield losses can be significant before deficiency symptoms appear.

It is possible to apply the amounts of nutrients removed by a specific crop. This works with nitrogen, since there are some crops where the suggested rate approximates what the plant removes. But it does not apply for other nutrients in Ontario. Some clay and clay loam soils have sufficient potassium to last many years. Applying potassium each year on those soils is not cost effective. One of the few advantages which clay soils have over coarser-textured soils is their ability to store potassium.

Use the OMAFRA accredited soil testing program, along with plant analysis and nutrient deficiency symptoms, to determine fertilizer requirements for a specific crop on a specific field.

## Benefits of the OMAFRA Accredited Soil Testing Program

The OMAFRA accredited soil testing program recommends application rates of nitrogen, phosphate, potash and magnesium, as well as the amount and type of lime required. The OMAFRA recommended fertilizer rates are provided in this publication. They are designed to produce highest economic yields when accompanied by good or above average management. Refer to Appendix A a list of accredited labs in Ontario.

## Soil Sampling

Sample soils with a sampling tube or shovel. Sample each field, or uniform section of a field, separately. Take at least 20 soil cores, 15 cm deep from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, take proportionately more cores. The more cores taken the more likely the soil sample will provide a reliable measure of the fertility in the field. One sample should not represent more than 10 hectares.

Collect soil in a clean pail. Break up lumps, mix the soil well and place in a soil sample box. Traverse the area in a zig zag pattern to provide a uniform distribution of sampling sites. Even if they are too small to fertilize separately, sample parts of a field that differ in appearance of soil or

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### Soil Tests from Other Laboratories

Only OMAFRA accredited soil tests can be relied on to provide accurate fertilizer recommendations. Be certain that the service you use is accredited. To be accredited, a laboratory must use OMAFRA approved testing procedures, must demonstrate acceptable analytical precision and accuracy, and provide the OMAFRA fertilizer recommendations.

A number of laboratories provide soil tests that include exchange capacity, aluminum and copper. These are not accredited by OMAFRA because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils, using exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided. See Appendix A for a list of accredited labs.

crop, in previous fertilization, manuring or liming separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

### When to Sample

Sample each field once every 2 or 3 years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and are not returned. Under these conditions sample yearly.

Analysis takes time. Ideally, take soil samples the previous fall from fields to be fertilized for spring planting. You may also take soil samples in summer.

### Sample Boxes and Information Sheets

Management practices that affect a soil test recommendation are manure application, legume sod plowed down,

and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation. Remember to record it on the field information sheet that must accompany the soil sample sent for analysis.

## Micronutrient Tests

OMAFRA accredited soil tests are available for manganese and zinc. With manganese, plant analysis, visual symptoms and the soil test are all useful. OMAFRA accredited soil tests are not available for boron, copper, iron, or molybdenum. Plant analysis is generally a better indicator of deficiencies of these nutrients.

## Contamination

Great care is required to prevent contamination of soil samples with micronutrients, particularly zinc.

- Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests.
- Do not use metal containers to collect and mix samples.
- Use clean plastic containers in good condition.
- Soil samples that have contacted galvanized surfaces are unsatisfactory for zinc soil tests.
- Be careful to keep dust around buildings etc. out of the samples.

## Soil Sampling

Micronutrient deficiencies or pH problems frequently occur in small patches in fields. In these cases, soil or plant analysis taken from the entire field are unlikely to find the problem. Sample problem areas separately.

TABLE 3-1. OMAFRA Accredited Soil Tests\*

Materials Analyzed	What is Analyzed <sup>1</sup>
Soils for crops, commercial turf, etc.	Plant-available phosphorus, potassium, magnesium, manganese and zinc; pH; lime requirement
Greenhouse media	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts
Nutrient solutions, water	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts; sulphates; chlorides

\* See Appendix A for a list of accredited laboratories.

<sup>1</sup> Soil organic matter can be useful for herbicide recommendations, but it is not an accredited test.

## Plant Analysis

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the *normal* and *critical* values for the crop can indicate whether nutrient supply is adequate for optimum growth.

Plant analysis is the basis of fertilizer recommendations for tree fruits and grapes. Plant analysis is presently recommended for apples, pears, plums, peaches, sour cherries, grapes (petiole analysis), strawberries, blueberries and raspberries. Plant analysis is a well established procedure and standards exist for accurate interpretation. Refer to OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

Plant analysis is also a useful supplement to soil testing for evaluating the fertility status of other crops. It is independent of soil testing and can provide a valuable second opinion, especially for phosphorus, potassium, magnesium and manganese. It has not been very reliable for nitrogen and zinc. There is no reliable soil test for boron and copper, so use plant analysis and visual symptoms to diagnose deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not usually indicate the cause of a deficiency or the amount of fertilizer required to correct it.

## Sampling

Since nutrient levels within a plant vary considerably with the age of the plant, time of sampling has a major effect on results. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, sample plants suspected of being nutrient deficient as soon as a problem appears. Take samples from a problem area, not the entire field.

Take samples from at least 20 plants distributed throughout the sampling area. Each sample should consist of at least 100 grams of fresh material. Sample problem areas separately. Do not contaminate the sample with soil. Even a small amount of soil invalidates the results, especially for micronutrients.

## Sample Preparation

Deliver samples of fresh plant material directly to the laboratory. If not delivered immediately dry your samples to prevent spoilage. They can be dried in an oven at 65°C or less, or in the sun, provided you take precautions to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several accredited laboratories in Ontario. (See Appendix A.)

## Fertilizer Recommendations

### Nitrogen

Nitrogen fertilizer recommendations for fruit crops are based on estimated crop requirements, and for tree fruits and grapes, on tissue analysis. Recommended rates are presented in the fertilizer section for each crop. Rates are adjusted downward if manure is applied, or if the previous crop contains perennial legumes, such as alfalfa.

To protect crop quality and avoid surface and groundwater pollution, make sure the combined application of fertilizer, manure, sewage sludge and other sources of nitrogen does not supply plant-available nitrogen in excess of the crop's requirement.

### Phosphate and potash

Phosphate and potash recommendations are based on OMAFRA soil tests. Use these tables only with OMAFRA accredited soil tests. Non-accredited tests may use extractants that pull out different amounts of nutrient, so they will not give correct answers if used with the OMAFRA tables.

Where a soil test is not available, a rough estimate of requirements can be obtained from these tables using the following guidelines:

- Where a field was fertilized regularly for years or heavily in recent years, use one of the rates of phosphate and potash recommended for the medium soil test rating.
- If a field has received little fertilizer in the past, use one of the rates recommended for a low soil test rating.

### Changes in Crop or Management

Fertilizer requirements on the OMAFRA soil test report are for specific crops using specific management practices. If you change your crop management program for legumes plowed down or manure applied, the fertilizer requirements must be adjusted. Use Table 3-5, *Average Amounts of Available Nutrients for Different Types of Manure*, and Table 3-6, *Adjustment of Nitrogen Requirements Where Crops Containing Legumes are Plowed Down to make adjustments*. If the crop is changed from that for which the recommendation was made, get a new recommendation by finding the appropriate table under the specific crop section in this publication.

## Soil Tests from Other Laboratories

Only OMAFRA accredited soil tests can be relied on to provide accurate fertilizer recommendations. Be certain that the service you use is accredited. To be accredited, a laboratory must use OMAFRA approved testing procedures, must demonstrate acceptable analytical precision and accuracy, and provide the OMAFRA fertilizer recommendations.

A number of laboratories provide soil tests that include exchange capacity, aluminum and copper. These are not accredited by OMAFRA because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils, using exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided. See Appendix A for a list of accredited labs.

crop, in previous fertilization, manuring or liming separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

### When to Sample

Sample each field once every 2 or 3 years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and are not returned. Under these conditions sample yearly.

Analysis takes time. Ideally, take soil samples the previous fall from fields to be fertilized for spring planting. You may also take soil samples in summer.

### Sample Boxes and Information Sheets

Management practices that affect a soil test recommendation are manure application, legume sod plowed down,

and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation. Remember to record it on the field information sheet that must accompany the soil sample sent for analysis.

## Micronutrient Tests

OMAFRA accredited soil tests are available for manganese and zinc. With manganese, plant analysis, visual symptoms and the soil test are all useful. OMAFRA accredited soil tests are not available for boron, copper, iron, or molybdenum. Plant analysis is generally a better indicator of deficiencies of these nutrients.

## Contamination

Great care is required to prevent contamination of soil samples with micronutrients, particularly zinc.

- Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests.
- Do not use metal containers to collect and mix samples.
- Use clean plastic containers in good condition.
- Soil samples that have contacted galvanized surfaces are unsatisfactory for zinc soil tests.
- Be careful to keep dust around buildings etc. out of the samples.

## Soil Sampling

Micronutrient deficiencies or pH problems frequently occur in small patches in fields. In these cases, soil or plant analysis taken from the entire field are unlikely to find the problem. Sample problem areas separately.

TABLE 3-1. OMAFRA Accredited Soil Tests\*

Materials Analyzed	What is Analyzed <sup>1</sup>
Soils for crops, commercial turf, etc.	Plant-available phosphorus, potassium, magnesium, manganese and zinc; pH; lime requirement
Greenhouse media	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts
Nutrient solutions, water	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts; sulphates; chlorides

\* See Appendix A for a list of accredited laboratories.  
<sup>1</sup> Soil organic matter can be useful for herbicide recommendations, but it is not an accredited test.

## Plant Analysis

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the *normal* and *critical* values for the crop can indicate whether nutrient supply is adequate for optimum growth.

Plant analysis is the basis of fertilizer recommendations for tree fruits and grapes. Plant analysis is presently recommended for apples, pears, plums, peaches, sour cherries, grapes (petiole analysis), strawberries, blueberries and raspberries. Plant analysis is a well established procedure and standards exist for accurate interpretation. Refer to OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

Plant analysis is also a useful supplement to soil testing for evaluating the fertility status of other crops. It is independent of soil testing and can provide a valuable second opinion, especially for phosphorus, potassium, magnesium and manganese. It has not been very reliable for nitrogen and zinc. There is no reliable soil test for boron and copper, so use plant analysis and visual symptoms to diagnose deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not usually indicate the cause of a deficiency or the amount of fertilizer required to correct it.

## Sampling

Since nutrient levels within a plant vary considerably with the age of the plant, time of sampling has a major effect on results. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, sample plants suspected of being nutrient deficient as soon as a problem appears. Take samples from a problem area, not the entire field.

Take samples from at least 20 plants distributed throughout the sampling area. Each sample should consist of at least 100 grams of fresh material. Sample problem areas separately. Do not contaminate the sample with soil. Even a small amount of soil invalidates the results, especially for micronutrients.

## Sample Preparation

Deliver samples of fresh plant material directly to the laboratory. If not delivered immediately dry your samples to prevent spoilage. They can be dried in an oven at 65°C or less, or in the sun, provided you take precautions to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several accredited laboratories in Ontario. (See Appendix A.)

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Soils testing excessive for phosphorus contain much more plant available phosphorus than is required by most crops. Applying additional phosphorus — whether from fertilizer, compost, manure or sewage biosolids — is unlikely to provide a yield increase, and may interfere with availability and uptake of other nutrients.

The rating system for soil test phosphorus evaluates the likelihood of a crop response to applied phosphorus. The risk of surface water contamination by phosphorus may be increased at higher soil test phosphorus levels. However, since phosphorus binds tightly to soil particles, the movement of soil from a field by erosion is also a major factor in determining the risk of surface water contamination. Because of this, the risk of surface water contamination by phosphorus cannot be based on a soil-test phosphorus level alone.

Wherever soil tests are very high or excessive, applications of any source of phosphorus should be guided by a phosphorus index. (See OMAFRA Factsheet *Determining the Phosphorus Index for a Field*, Order No. 98-079.) A phosphorus index can rank the relative risk of surface water contamination for applications made to a particular area of land. It also determines maximum application rates if manure is applied, and required setbacks from water-courses.

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

## Soil Acidity And Liming

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most crops grow well in a soil pH range from 6.0 to 8.0.

To correct soil acidity, broadcast ground limestone and work it into the soil at rates determined by soil test. Table 3-2, *Soil pH at which Lime is Recommended for Ontario Crops*, shows the pH values below which lime is recommended and the target soil pH to which soils should be limed, for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

### The Buffer pH

Different soils with a similar soil pH value will require different amounts of lime to bring the pH to a particular desired level, depending chiefly on the clay and organic matter content of each soil. The soil pH determines which soils need to be limed. But a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH) use Table 3-3, *Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH*, to determine the amount of lime required to reach different target soil pH values required for different crops.

**TABLE 3-2. Soil pH at which Lime is Recommended for Ontario Crops**

Crops	Soil pH below which Lime is recommended	Target Soil pH*
<b>Coarse and Medium-Textured Mineral Soils (sand, sandy loams, loams and silt loams)</b>		
Perennial legumes, oats, barley, wheat, beans, peas, canola, flax, tomatoes, raspberries, strawberries, new plantings of tree fruits or grapes, all other crops not listed below (except blueberries)	6.1	6.5
Corn, soybeans, rye, grass, hay, pasture, tobacco	5.6	6.0
Potatoes	5.1	5.5
<b>Fine-Textured Mineral Soils (clays and clay loams)</b>		
Alfalfa, cole crops, rutabagas	6.1	6.5
Other perennial legumes, oats, barley, wheat, soybeans, beans, peas, canola, flax, tomatoes, strawberries, raspberries, new plantings of tree fruits or grapes, all other crops not listed above or below (except blueberries)	5.6	6.0
Corn, rye, grass, hay, pasture	5.1	5.5
<b>Organic Soils (peats and mucks)</b>		
All field and vegetable crops	5.1	5.5

\* Where a crop is grown in rotation with other crops requiring a higher pH (e.g. corn in rotation with wheat or alfalfa), lime the soil to the higher pH.

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Potatoes	5.1	5.5
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Corn, rye, grass, hay, pasture	5.1	5.5
<b>Organic Soils (peats and mucks)</b>		
All field and vegetable crops	5.1	5.5

\* Where a crop is grown in rotation with other crops requiring a higher pH (e.g. corn in rotation with wheat or alfalfa), lime the soil to the higher pH.

**TABLE 3-3. Lime Requirements to Correct Soil Acidity based on Soil pH & Soil Buffer pH**

Buffer pH	Target soil pH = 6.5 <sup>1</sup>	Target soil pH = 6.0 <sup>2</sup>	Target soil pH = 5.5 <sup>3</sup>
Ground limestone required — t/ha (based on an Agricultural Index of 75)			
7.0	2	1	1
6.9	2	1	1
6.8	2	1	1
6.7	2	2	1
6.6	3	2	1
6.5	3	2	1
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	8	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

<sup>1</sup> Lime if soil pH below 6.1  
<sup>2</sup> Lime if soil pH below 5.6  
<sup>3</sup> Lime if soil pH below 5.1

### Limestone Quality

*Calcitic limestone* consists largely of calcium carbonate. *Dolomitic limestone* is a mixture of both calcium and magnesium carbonates. Use dolomitic limestone on soils with a magnesium soil test of 100 or less. It is an excellent and inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

The 2 main factors affecting the value of limestone for soil applications are *neutralizing value* and *particle size*. Neutralizing value is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. It is expressed as a percentage of the neutralizing value of pure calcium carbonate. Limestone that neutralizes 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

The second factor affecting the value of limestone as a neutralizer of acidity is particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone; therefore it neutralizes acidity much more slowly — so slowly it is of little value. The calculation of a fineness rating for ground limestone is illustrated in Table 3-4, *Example Calculation of the Fineness Rating of Limestone*.

**TABLE 3-4. Example Calculation of the Fineness Rating of Limestone**

Particle Size	% of Sample	Effectiveness Factor
Coarser than #10 sieve <sup>1</sup>	10	x 0 = 0
#10 to #60 sieve	40	x 0.4 = 16
Passing through #60 sieve	50	x 1.0 = 50
Fineness rating		= 66

<sup>1</sup> A #10 Tyler sieve has wires spaced 2.0 mm, and a #60 Tyler sieve has wires spaced 0.25 mm apart.

### The Agricultural Index

Some means of combining the neutralizing value and the fineness rating is needed to compare various limestones available. The index developed in Ontario to do this is the *Agricultural Index*.

The Agricultural Index compares the relative value of different limestones for neutralization of soil acidity. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If 2 ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the OMAFRA soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

### Calculating Limestone Application Rates

$$\text{Application rate} = \frac{75}{\text{Agricultural Index}} \times (\text{application rate from soil test})$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply  $75/90 \times 9 = 7.5$  t/ha.

The Agricultural Index does not provide information about magnesium content. Use dolomitic limestone on soils low in magnesium.

### **Tillage Depth**

Lime recommendations presented here should raise the pH of the top 15 cm of a soil to the listed target pH. If the soil is plowed to a lesser or greater depth than 15 cm, proportionately more or less lime is required to reach the same target pH. Where reduced tillage depths are used, reduce the rates of application proportionately. More frequent liming will be needed.

### **Lowering Soil pH**

On soils with pH values below 6.5 you can lower the pH (make the soil more acid) by adding sulphur or ammonium sulphate. This is not advisable for most crops, as it only hastens the time when lime will be required. If the soil pH is above 6.5, it is not advisable and also usually quite impractical, to lower the soil pH because of the very large amounts of sulphur or ammonium sulphate required.

## **Managing Soil Organic Matter**

Soil organic matter helps:

- maintain soil structure and tilth
- improve soil moisture holding capacity
- increase the soils ability to hold nutrients
- improve internal drainage.

Maintaining adequate soil organic matter levels can help maintain crop yields, particularly in years with bad weather.

Increasing soil organic matter is a slow process. Only a small part of organic matter added to the soil becomes stable humus. It is important to keep as much organic matter in the soil as possible by:

- reducing soil erosion
- eliminating unnecessary runoff
- avoiding excessive tillage.

Organic matter additions also, over time, increase the total soil organic matter. These may be in the form of livestock manures, biosolids, forage crops or cover crops. Cover crops are discussed in Chapter 5.

Manure is an important organic amendment that contains considerable amounts of nitrogen and potassium, and smaller amounts of available phosphorous. When using

manure, reduce fertilization rates as indicated either in Table 3-5, *Average Amounts of Available Nutrients for Different Types of Manure*, or based on an analysis of the manure nutrient content.

Biosolids derived from paper mill fibre have been used in orchards and vineyards to maintain soil organic matter. However, before this material can be applied to land, you must have a Certificate of Approval issued by the Ontario Ministry of the Environment (MOE) for the site. Rates depend upon the nitrogen content of the material and can be in the range of 25–30 dry t/ha. However, the MOE has final approval of the material and the applied rate. Any application restrictions are included as conditions on the Certificate of Approval.

Sewage biosolids are a source of nitrogen, phosphorous and organic matter. As with paper mill fibre, a Certificate of Approval is required for the site receiving sewage sludge. Before sewage sludge can be applied to land it must qualify under the MOE guidelines. These guidelines place restrictions on the types of crops receiving sewage sludge and the waiting periods between application and harvest. For tree fruits and grapes the waiting period is 3 months. The required waiting period between sewage sludge application and small fruit (strawberries, raspberries and blueberries) harvest is 15 months. For more information refer to OMA-FRA Factsheet *Land Application of Sewage Biosolids for Crop Production*, Order No. 95-069.

Some processing companies that contract crops may have concerns about sludge applications to fields where certain crops are grown. Please contact companies prior to spreading sewage sludge to confirm they will accept your crop.

Straw and spoiled hay are other excellent sources of organic matter. As manure becomes more costly and difficult to obtain, straw or hay will be more widely used. Seven tonnes per hectare of straw or old hay will supply approximately the same amount of dry matter as 22 t/ha of cattle manure.

## **Adjustments to Fertilizer Recommendations**

### **Adjustment for Legumes Plowed Down**

When perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. Unfortunately, the rate of release is variable, and very dependent on soil and weather conditions. Late release of nitrogen may pre-dispose fruit crops to winter injury. If perennial legumes are grown



**TABLE 3-5. Average Amounts of Available Nutrients for Different Types of Manure**

Manure	Average Dry Matter	Available Nitrogen <sup>2</sup> Spring 1 day	Available Nitrogen <sup>3</sup> Spring not incorp.	Available P <sub>2</sub> O <sub>5</sub> <sup>4</sup>	Available K <sub>2</sub> O <sup>5</sup>
<b>kg/1000 L (lb/1000 gal)</b>					
Liquid dairy	6.5%	1.6 (16)	0.6 (6)	0.7 (7)	3 (30)
Liquid hog	3.6%	2.6 (26)	0.7 (7)	1.1 (11)	2 (20)
Liquid poultry	8.0%	6.1 (61)	1.7 (17)	2.5 (25)	3.4 (34)
Liquid biosolids (sludge) <sup>6</sup>	4.4%	1.2 (12)	0.6 (6)	1.3 (13)	0.2 (2)
<b>kg/tonne (lb/ton)</b>					
Solid biosolids	36%	1.5 (3)	0.75 (1.5)	11 (22)	0 (0)
Solid poultry	49%	11.5 (21)	6 (12)	9 (18)	12.5 (25)
Solid dairy	20%	1.5 (3)	0.7 (1.4)	1.5 (3)	5.5 (11)
Solid beef	27%	1.5 (3)	0.75 (1.5)	1.5 (3)	7 (14)

<sup>1</sup> Nutrient values based on average analysis results for over 700 samples. There are large variations between different manures, so a manure analysis is your best guide to nutrient availability.

<sup>2</sup> Nitrogen based on spring application, incorporated within 24 hours.

<sup>3</sup> Nitrogen based on spring application, not incorporated (i.e. on soil surface for over 7 days).

<sup>4</sup> Phosphate from manure or biosolids is assumed to be 40% as available as that in manufactured fertilizer in the year of application.

<sup>5</sup> Potash from manure or biosolids is assumed to be 90% as available as that in manufactured fertilizer in the year of application.

<sup>6</sup> For biosolids (e.g. sewage sludge), you must get a certificate of approval from your local MOE office. This can take up to 6 months.

prior to planting fruit crops, use Table 3-6, *Adjustment of Nitrogen Requirements where Crops Containing Legumes are Plowed Down* to adjust nitrogen fertilizer applications.

## Manure

Ontario livestock farms generate over 33 million tonnes of manure. Proper management of nutrients from manure is essential for optimum economic benefit to the farmer with minimal impact on the environment.

## Value of Manure

The value of manure in crop production is often underestimated. Manure contains all nutrients needed by crops but not necessarily in the proportions needed for specific soil and crop conditions. In addition to nitrogen, phosphorus and potash, manure contains many secondary and micronutrients, as well as organic matter that helps build and maintain soil structure.

## Manure Analysis

Manure analysis is necessary because the quantities of nutrients contained in manure, especially phosphorus and potash, vary from farm to farm. Type of livestock, ration, bedding, added liquids and storage system all affect the final nutrient accredited analysis. A manure analysis is available from several laboratories in Ontario. Perform an analysis after complete agitation, or thorough mixing, each time the storage is emptied (e.g. spring and fall). After several analyses, a trend develops, and you can limit sampling to major changes in ration or other management factors.

**TABLE 3-6. Adjustment of Nitrogen Requirements where Crops Containing Legumes are Plowed Down**

Type of Crop	For all crops deduct from N requirement kg N/ha
less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	100
perennial legumes seeded and plowed in same year	45 <sup>1</sup>
soybean and field bean resi- due	0

<sup>1</sup> Applies where the legume stand is thick and over 40 cm high

When sending a sample to the lab fill a plastic jar (about 2 L capacity) half-full, cover and place in a plastic bag and store in a cool place until shipping. Analysis should include total nitrogen, ammonium-nitrogen (NH<sub>4</sub>-N), phosphorus, potassium and dry matter. Ontario labs send back analysis results with percentages for nitrogen, phosphorus, potassium and dry matter as well as mg/kg (or ppm) of ammonium-nitrogen. Percentages for phosphorus and potassium from manure are converted to commercial P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O equivalents and commercial fertilizer reductions are given.

For more information on manure analysis, the available nitrogen in manure, and calibrating manure spreaders, see OMAFRA Publication 296, *Field Crop Production Recommendations*.



### Long Term Value of Manure

The long term availability of phosphorus (P), potassium (K), magnesium, zinc or manganese from previous manure applications is best estimated by soil testing. Application of large quantities of manure over time can result in high levels of available P and K in soils. Manure also contributes other plant nutrients and organic matter to soil that may be of some long term value.

Most of the available nitrogen in manure is used by the crop or lost during the first growing season following application. The remaining organic nitrogen becomes available in small, diminishing quantities in succeeding years. Generally the amount of residual nitrogen from one application is too small to make a practical difference in nitrogen recommendations for a crop. However, where manure is applied regularly to the same field, there can be significant residual nitrogen available for a crop. Use the soil test for P and K to measure residual phosphorus and potassium from manure applications.

### Environmental Concerns with Manure

Using manure to meet, but not exceed, crop nutrient needs helps to minimize nutrient losses to the environment. However, take care to avoid manure contamination into streams from erosion, surface and tile runoff.

Do not spread manure in the winter and early spring because of the potential for runoff to surface water. The fate of the first meltwater following manure application determines whether this will be a problem or not. This practice should not be a part of a nutrient management plan. In years when winter spreading may be necessary, select fields where there is no risk of runoff to surface water.

Rain can cause organic nitrogen to wash into streams if manure has been applied to unprotected cropland. Phosphorus, attached to soil particles, can be carried to streams by soil erosion. Conservation practices can reduce the chances of nutrients polluting waterways.

Do not spread liquid manure within 10 m of a watercourse (5 m for solid manure) or more if the phosphorus index is high.

Flow in tile drains can become contaminated if manure enters a catchbasin or travels through soil cracks to the tiles. With liquid manure, maintain a 10 m buffer around a catchbasin or surface inlet (5 m with solid manure). If there is any history of tile contamination via soil cracks or macropores, tillage prior to application is recommended.

Applying nutrients in manure or fertilizer in excess of crop requirements can contaminate groundwater, particularly on shallow soils over bedrock, soils with a water table close to the surface, or very sandy soils where leaching is a concern. Groundwater contamination can occur by mass flow through cracks and holes to groundwater, or through leaching of nitrates through the soil.

### Food Safety Concerns with Manure Application and Timing

Fruit and vegetable crops can become contaminated in the field if they contact microbes that cause human disease. These microbes can come from manure fertilizers and manure-based composts. They can contaminate fruit or vegetables by direct soil-to-produce contact or through rain-splashed soil. Examples of harmful microbes are some, but not all, strains of *E. coli*, *Salmonella*, *Campylobacter*.

The longevity of harmful microbes in manure is not well known. Proper composting of manure, which results in heating to a specific temperature for a specific period of time, reduces the level of most pathogens. Aged manure (manure stored in piles and sometimes turned) may contain considerably more pathogens than properly composed manure (manure turned/mixed frequently, temperature monitored and maintained). Composting may not completely eliminate all pathogens. Take appropriate precautionary measures. Incorporation of manure will minimize, but may not eliminate, the risk of microbial contamination of produce.

**Manure application to fruit and vegetable crops is not recommended before harvest, in the year of harvest.**

Concerns about food safety and the possible introduction of food borne pathogens to windfall apples by application of manure to the orchard floor is discussed in the *Code of Practice for the Production and Distribution of Unpasteurized Apple and Other Fruit Juice/Cider in Canada*.

Where juice apples are being produced, it may not be appropriate to apply fresh or composted manure to the orchard. Food borne pathogens can be introduced into orchards via manure and these pathogens can be a significant threat in the contamination of apples used to produce unpasteurized juice/cider.

The Code of Practice can be found on the Canadian Food Inspection Agency (CFIA) web site at [www.cfia-acia.agr.ca/english/plant/processed/code-eng.html](http://www.cfia-acia.agr.ca/english/plant/processed/code-eng.html). You can also contact the CFIA office at 416-954-9033.

## Fertilizer Materials

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to:

- differences in the amount of salts contained in the fertilizer per unit of plant nutrient
- differences in solubility of the salts in the soil
- a few specific materials or elements are particularly toxic (for example, ammonia and boron).

The most common nitrogen fertilizers used in fruit crops are calcium ammonium nitrate, ammonium nitrate, calcium nitrate, urea, and ammonium sulphate. In most cases different sources produce equal yields. Choose your material based on availability, equipment for handling, and cost per hectare of nitrogen, plus the cost of application.

First calculate the cost per kilogram of nitrogen for various sources delivered to the farm. Depending on the rate of application, the cost per hectare can be determined. Add to this the cost of application per hectare before deciding which nitrogen source to use.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used. Table 3-7, *Fertilizer Materials — Secondary and Micronutrients* and Table 3-8, *Fertilizer Materials — Primary Nutrients*, show the percentage of fertilizer nutrient contained in different materials.

Various fertilizer companies have available, in addition to the micronutrient sources listed in Table 3-7, premixes containing one or more micronutrients.

### Soluble Salts In Farm Soils

High concentrations of water-soluble salts in soils can prevent or delay germination of seeds, and can either kill transplants and established plants or seriously retard their growth.

Since Ontario soils are naturally low in soluble salts, soluble salts rarely cause a problem in crop production and are not routinely measured in soil tests.

Soluble salts in soils can result from excessive applications of fertilizers and manures, runoff of salts applied to roads, and chemical spills on farm land. High concentrations of soluble salts in or near a fertilizer band can seriously harm plant growth without affecting the salt concentrations in

**TABLE 3-7. Fertilizer Materials — Secondary and Micronutrients**

<b>Magnesium (Mg)</b>	
Dolomitic Limestone	6-13% Mg
Epsom Salts (Magnesium sulfate)	10.5% Mg
Sulfate of Potash Magnesia	11% Mg
<b>Boron (B)</b>	
Sodium Borate	12-21% B
<b>Copper (Cu)</b>	
Copper Sulfate	13-25% Cu
Copper Chelates	5-13% Cu
<b>Manganese (Mn)</b>	
Manganese Sulfate	26-28% Mn
<b>Molybdenum (Mo)</b>	
Sodium Molybdate	39% Mo
<b>Zinc (Zn)</b>	
Zinc Sulfate	36% Zn
Zinc Chelates	7-14% Zn
Zinc Oxysulfate	18-36% Zn

**TABLE 3-8. Fertilizer Materials — Primary Nutrients**

<b>Nitrogen Materials</b>	<b>Form</b>	<b>% Nitrogen (N)</b>
Ammonium nitrate	Dry	30 to 34
Urea	Dry	45 to 46
Calcium Ammonium Nitrate	Dry	23
Calcium Nitrate	Dry	15.5
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid <sup>1</sup>	20
Urea-Ammonium nitrate	Liquid <sup>1</sup>	28
Anhydrous ammonia	Liquid <sup>1</sup>	82
<b>Phosphate Materials</b>		<b>% Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>
Single superphosphate		20
Triple superphosphate		44 to 46
Monoammonium phosphate		48 to 52
Diammonium phosphate (18-46-0)		46
<b>Potash Materials</b>		<b>% Potash (K<sub>2</sub>O)</b>
Muriate of potash		60 to 62
Sulfate of potash		50
Sulfate of potash magnesia (11% Mg)		22
Potassium nitrate (13-0-44)		44

<sup>1</sup> Liquid under pressure

the remainder of the soil. Excessive soluble salts damage plants by restricting water uptake and pulling water out of plant tissues. Salt concentration in soil increases as water supply decreases. For this reason, plant growth is most affected by soluble salts in periods of dry weather, and in soils with low moisture holding capacity.

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water-soluble salts, the higher the conductivity. Table 3-9, *Soil Conductivity Reading Interpretation* interprets soil conductivity readings.

For greenhouse soils the OMAFRA accredited soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using this method, conductivity readings up to 3.5 millisiemens/cm are acceptable.

## Fertilizer Placement

Phosphorus is important for early growth. It is more available if placed near or in the root zone. For transplanted crops, use a high phosphorus starter solution.

Nitrogen fertilizers readily dissolve in soil water and move easily through soil to plant roots. Placement of nitrogen is less important than for phosphorus. Part of the nitrogen requirement is usually broadcast, injected or worked into the soil before planting, often to hasten the breakdown of the cover crop. In strawberries, a portion of the nitrogen can be side-dressed after planting, rather than applied all at once before planting. This minimizes leaching and prevents too much early vegetative growth at the expense of roots.

Too much potassium applied in a band at planting or in the transplant water can injure young transplants. This danger of fertilizer injury is greater on sands and sandy loams than on silt loam and clay loam soils. On coarse textured sand and sandy loams, broadcast and work part of the potassium fertilizer requirements into the soil before planting.

## Water Quality

Water is a valuable resource. A clean and abundant supply of water is critical to the success of your farm business and the health of your family. Water is also shared by others, including fish and wildlife. You have a right to expect an ample supply of clean water, and it is your responsibility to make sure the water leaving your farm is abundant and clean for the next user.

Farm operations affect water quality in many ways. Soil erosion, manures, septic system effluent, milkhouse wastes, pesticides and fuels can affect surface water quality. Nutrients, manures, pesticides and fuels moving down through the soil into the groundwater can affect groundwater quality.

The greatest water quality challenges affecting farmers involve bacteria (from manures), nitrates and sediment. The following problems can be minimized using the practices listed.

### Bacteria Contamination

- Contain runoff from manure storages, livestock yards and silos.
- Avoid spreading manure on frozen or snow-covered ground.
- Make sure your well is properly maintained and protected from surface contamination.
- Properly treat or store milkhouse waste water.
- Ensure your domestic septic system is working properly and is not discharging into a drainage system.

### Soil Erosion

- Adopt conservation tillage practices.
- Install erosion-control structures.

TABLE 3-9. Soil Conductivity Reading Interpretation\*

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0 - 0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26 - 0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46 - 0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants
0.71 - 1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

\* where conductivity is measured in a 2:1 water:soil paste for Ontario field soils, using OMAFRA accredited procedures

### **Nitrate Contamination**

- Complete a nutrient-management plan for your farm. (See OMAFRA Factsheet *Nutrient Management Worksheet for Manure*, Order No. 98-027.)
- Avoid spreading excessive amounts of manure or fertilizer on a field.
- Where a lot of manure and forages are used, the nitrate soil test can help to determine nitrogen requirements.
- Reduce nitrogen fertilizer when the previous crop was a legume or when manure was applied. (See section on Manure, page 21.)

### **Pesticide Contamination**

- Store pesticides properly and keep as little as possible in storage.
- Stay away from ditches and other sources of water when spraying.
- Clean up spills quickly and thoroughly.
- Be careful not to mix more pesticide than required.

### **Fuel Contamination**

- Store fuel away from wells, ditches, etc.
- Use automatic shut-off nozzles to prevent spills.

The following Best Management Practices publications contain more information on water quality problems and solutions, soil conservation measures and nutrient and manure use.

Best Management Practices – Water Management

Best Management Practices – Field Crop Production

Best Management Practices – Nutrient Management

Best Management Practices – Pesticide Storage, Handling  
and Application

Best Management Practices – Water Wells

These publications are available through the Ontario Federation of Agriculture, which can be reached by tel: 416-485-3333, fax: 416 485-9027 or email: [research@ofa.on.ca](mailto:research@ofa.on.ca).



# 4. Pest Management

## Integrated Pest Management

Growers, crop advisors and researchers realized in the late 1960's that it was not sustainable to rely totally on chemical pesticides for pest control. This led to the development of more viable alternatives. The first major programs for IPM were developed for peaches, apples, grapes, onions and carrots. In Ontario today there are 22 horticultural, greenhouse and field crop commodities with IPM programs in various stages of development and delivery.

### The Concept

Integrated pest management (IPM) uses an interdisciplinary approach to incorporate various strategies to minimize adverse effects of pesticides on the environment, while maintaining maximized economic returns.

The emphasis of IPM is not to completely eradicate pests but to hold them below economically damaging levels. In other words, some damage to the crop is tolerated as long as this damage does not exceed the cost of the control. Using an ecological approach, IPM systems are based on a thorough understanding of both the crop and its pests, and their interactions with each other and the environment.

For fruit growers, IPM is a tool you can incorporate into your fruit production and management. To use IPM successfully, you must:

- be able to identify the pest
- understand the pest's biology
- know how to monitor the activity of each pest
- be aware of thresholds and timing of control tactics
- be able to determine the best control strategy for each situation that arises.

These control strategies may include chemical controls, conservation and augmentation of beneficial organisms, cultural management techniques, and a thorough knowledge of pesticides and their effect on pests, non-target organisms and the environment.

### How to Get Information

Fruit producers in some parts of the province have formed "Grower Funded IPM" groups where participating grow-

ers hire their own pest management scout(s). The scouts monitor each orchard or berry field for pests and report directly back to individual growers. Growers then use this collected information, along with their knowledge of IPM, to make management decisions on whether to spray or not.

For apple growers, see OMAFRA Publication 310, *Integrated Pest Management for Apple Orchards in Ontario*. Various factsheets outlining IPM for specific fruit pests are also available.

Current information is available on the crop page of OMAFRA's web site at [www.gov.on.ca/omafra/english/crops/index.html](http://www.gov.on.ca/omafra/english/crops/index.html). Additional information is supplied via newsletters, meetings, field monitoring demonstrations, and pest management workshops.

## Pest Resistance to Insecticides, Fungicides, Miticides

Pests are said to be resistant when they are able to survive exposure to rates of pesticides that previously controlled them. Generally, resistance to a pesticide develops after repeated exposure to a specific chemical. Resistance occurs because a few naturally occurring resistant individuals survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually replace the susceptible ones. Eventually only a resistant population remains, which the pesticide cannot control.

Resistance to pesticides can develop very quickly. Do not use the same chemical repeatedly unless it is used in rotation with a different chemical or used in combination with other chemicals having a different mode of action. This practice reduces the likelihood of resistance developing in the pest population.

Be aware that many chemicals with the same active ingredients or the same mode of action are marketed under different brand names. For example, the chemical *cypermethrin* is marketed under the brand names Ripcord and Cymbush.



As well, different chemicals may have the same mode of action. For example both Benlate and Senator act on the same site in the fungus and, therefore, have the same mechanism of control. Using Benlate after Senator is equivalent to using Benlate after Benlate, since resistance develops to both chemicals at the same time, even though only one may have been used repeatedly. The same applies for many synthetic pyrethroids.

## **Insecticides**

### **Organophosphates**

Resistance to this relatively older group of insecticides occurs in a number of major pests, namely tentiform leafminer on apples, oblique-banded leafroller on apples and pears, pear psylla on pears, and Oriental fruit moth on peaches and nectarines. Other orchard pests are suspected to have low levels of resistance to this group of compounds, but this is largely unconfirmed.

Over the last few years, tests have demonstrated variable levels of resistance to Imidan and Guthion in oblique-banded leafroller populations in apple, pear, raspberry, sweet cherry and peach plantings across Southern Ontario. Resistant populations have been identified in the regional municipalities of Niagara and Durham, and the counties of Essex, Kent, Northumberland and Grey.

In most areas of Ontario, there is now confirmed resistance to some organophosphate insecticides (including Imidan, Parathion, and Guthion/APM) in Oriental fruit moth (OFM) populations. The level of resistance has begun to drop where growers have introduced insecticides from different chemical families — Lorsban and pyrethroid insecticides — into their OFM control program.

### **Synthetic Pyrethroids**

Tentiform leafminer has become resistant to all synthetic pyrethroids (Pounce, Decis, Cymbush and Ripcord) in many apple orchards in Ontario.

Pear psylla resistance to pyrethroids has been documented in western North America and some pear orchards in the Niagara Peninsula. Resistance may occur in other parts of the province.

Surveys for resistance to OFM have been conducted at 6 locations in the Niagara region and 1 location in Essex County. Four years of results show that resistance levels in adult Oriental fruit moth (OFM) to pyrethroid insecticides remains stable and at low levels. These low levels have

not been expressed in larvae and have not resulted in control failures in the field when insecticides have been timed correctly to control hatching OFM larvae. This means that the short-term resistance management strategy of using Lorsban only for first generation and the pyrethroid insecticides for the 2<sup>nd</sup> to 4<sup>th</sup> generations, is working.

The repeated use of pyrethroid insecticides (more than once per season) is discouraged in Ontario orchards because of the potential for further resistance development and this group's toxicity to beneficial insects.

### **Lannate**

Many cases of tentiform leafminer resistance to Lannate have been documented in Norfolk County, as well as other apple growing counties. Avoid this product where such resistance exists.

## **Fungicides**

### **Benlate/Senator**

Cases of resistant apple scab have been documented in most of the apple growing areas of the province. Resistance to Benlate has also been documented for brown rot on peaches and cherries, as well as for Botrytis on strawberries and grapes.

### **Equal**

Apple scab is resistant to Equal (and a previously marketed formulation known as Cyprex) in a moderate percentage of orchards in Ontario. Resistance to Equal is persistent for many years. This chemical no longer controls apple scab once resistance is established in an orchard.

### **Rovral**

*Botrytis*, the causal agent of bunch rot of grapes, has developed resistance to Rovral in many vineyards after 4 years of use. Resistance is expected to develop to grey mould in strawberry fields as well. However, the resistant form of the fungus does not survive well, and declines when Rovral is not used for several years. If Rovral is only used once or twice per season, but not consecutively, resistance should remain at low levels and Rovral should remain effective.

Tests on *Monilinia fructicola*, the causal agent of brown rot on cherries, plums, peaches and nectarines, indicate there are no resistant populations in Ontario. However, there are resistant populations in New Zealand, and Australia. Therefore, do not use Rovral more than twice per season. This will help prevent resistance.

Rovral has 3 main methods of action against brown rot:

1. **Protection Activity:** the fungicide prevents infection from occurring when the residue is on the surface prior to the infection period.
2. **After Infection Activity:** the fungicide penetrates infected tissue and slows or stops fungal growth. This activity of Rovral is greatest with excellent coverage and when application is made within 48 hr from start of the wetting period.
3. **Antisporulant Activity:** the fungicide penetrates infected blossom tissue and greatly reduces, but does not totally prevent, production of brown rot spores.

Field experience shows that Rovral performs best and is most effective when applied as a protectant prior to an expected wetting/infection period. Use Rovral primarily as a protectant fungicide without relying upon its after-infection and antisporulant activities. Do not apply more than 1 application of Rovral during the bloom period, and not more than once during the pre-harvest period. Do not use Rovral more than twice per season, to avoid rapid development of resistance.

### **Ronilan**

Strawberry growers note that the fungicide Ronilan is in the same chemical family as Rovral. Resistance management practices for Rovral also apply to Ronilan.

### **Miticides**

#### **Kelthane**

European red mite resistance to this pesticide is widespread in Ontario orchards. A 1992 survey showed that 84% of European red mite populations tested in Ontario apple orchards had some level of resistance to Kelthane. Mite pressure, and the use of Kelthane, has increased in peach, nectarine and plum orchards. Many of these blocks now contain populations of European red mite populations that are either resistant or have mixed resistance to Kelthane. In grape vineyards, where Kelthane is often applied 2–3 times, it does a partial or poor job controlling European red mite. In strawberries, two-spotted spider mite populations have also demonstrated resistance to Kelthane.

Resistance to Kelthane is not stable and if it is not used for 3–5 years, the mite population gradually loses its resistance. However, if the chemical is used repeatedly (in 1 season or year-after-year) resistance returns quite quickly.

### **Apollo**

Mite resistance to Apollo has now been found in a few Ontario apple orchards in southern Ontario. It is believed this resistance is not widespread. Resistance has occurred where Apollo has been applied repeatedly in one season, or applied too late in the season, causing season-long selection pressure on mite populations and poor control. Therefore, it is important to follow these recommendations. Do not use Apollo every year. Only use Apollo once in the season of use. Apply Apollo at the prescribed early timing of calyx to 2 weeks after calyx, when mite populations are synchronous and in the first summer generation egg stage. Follow a similar strategy of early season use on peach/nectarine to control mites.

### **Nematodes**

The most common nematodes in Ontario crops are root-lesion, (*Pratylenchus*) and root-knot (*Meloidogyne*). Secondary genera are pin (*Paratylenchus*), dagger (*Xiphinema*), bulb and stem (*Ditylenchus*), and cyst (*Heterodera*). Dagger nematode is mainly a virus vector on specific grape, raspberry and some apple varieties.

The thresholds for economic damage on most fruit crops are:

Lesion nematode:	1000/kg soil, 500/kg soil on strawberries
Root-knot:	1000/kg soil
Pin:	5000/kg soil
Dagger:	100/kg soil
Bulb and stem:	100/kg soil

Nematode problems are most frequently found in sandy loam and sandy soils. Always sample these soils for nematode populations before planting fruit crops. Nematode problems are not usually found in clay or clay loam soil types. Sample these soils for nematodes before planting in replant sites, or where fruit crops have been recently grown. Also sample clay or clay-loam soils for dagger nematode on virus-susceptible grapes, raspberry or tree fruit, and for pin nematode on rhubarb, rose and gladiolus.

Information on how to sample soil for nematodes, and where to send the samples is found in Appendix E, *Diagnostic Services*.

### **Nematodes in Berry Crops**

Root-lesion nematode damage on strawberries usually consists of a discoloration of the fine feeder roots and tiny, brown, scratch-like lesions on the young adventitious

roots. These lesions merge to form large brown areas on the roots. There is also evidence that root-lesion nematodes are involved in the black root-rot complex and that they aggravate Verticillium wilt of strawberries.

Root-lesion nematode damage on raspberries results in the same scratch-like lesions for strawberries. In addition, the canes are thinner than normal and fewer canes are produced per crown; cane height is not usually reduced. Up to 25% of the first year canes may be killed by severe infestations of these nematodes.

### Nematodes in Tree Fruits

Root-lesion nematodes can be a major cause of orchard replant failures. They can also cause a decline in vigour of existing peach and cherry orchards. These nematodes kill the fine feeder roots, and cause small brown lesions on the white lateral roots. These lesions can merge and discolour the entire root system. Severely affected trees may not have any feeder roots and if the tree is a replant it usually dies. The most striking above ground indication of nematode damage in an orchard is a general lack of uniformity of trees.

### Nematode Control

Exclude cover crops such as clovers and buckwheat from strawberry and orchard rotations because they are excellent hosts for root-lesion nematodes. If a cereal grain is to be used for one whole growing season, wheat or barley is the best choice. Certain mustards and other crucifers, African marigolds, and specific sorghum x sudan-grass hybrids may effectively reduce nematode numbers in the soil, but one or more growing seasons is required. See Table 5-1, *Characteristics of Cover Crops Grown in Ontario*, page 39, for more information.

A good weed control program is essential the year before planting fruit crops because nematode populations can build on many weed species. Keeping land fallow the year before planting also reduces nematode numbers, but has drawbacks, such as susceptibility to erosion.

In orchards, choose ground covers between the rows that do not support nematodes, such as annual or perennial ryegrass.

Pre-plant soil fumigation is the most effective method of controlling nematode problems. It is practical when planting a new orchard or when replanting an orchard on an old tree site. Custom operators can do either broadcast fumigation or tree-row. Tree-row application (treating a 2–2.5 m strip centered on the row) is more economical.

Treat areas that harbour potential nematode problems before planting. Refer to Table 4-1, *Control of Nematodes and Related Problems in Strawberry and Raspberry Plantings in Mineral Soils* and Table 4-2, *Control of Nematodes and Related Problems in Orchards on Mineral Soils*. See OMA-FRA Factsheet *Nematode Management for Ontario Orchards*, Order No. 95-061.

**TABLE 4-1. Control of Nematodes & Related Problems in Strawberry & Raspberry Plantings in Mineral Soils**

To Control	Material	Broadcast* (L/ha)
Nematodes only	Telone IIB	170
	Vorlex Plus	55-130
	Vorlex Plus CP	55-220
	Busan 1020	470
Verticillium & Nematodes	Telone C-17-R	200-380
	Vapam**	470-900
	Vorlex Plus	225-450
	Vorlex Plus CP	220-440
	Busan 1020	470-900

\* Use higher rates for heavier soils, e.g. clay loams.

\*\* Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

**TABLE 4-2. Control of Nematodes & Related Problems in Orchards on Mineral Soils**

To Control	Material	Broadcast* (L/ha)
Nematodes only	Telone IIB	200
	Vorlex Plus	55-130
	Vorlex Plus CP	55-220
	Busan 1020	470
Nematodes, Diseases	Telone C-17-R	280
	Busan 1020	470-900
Nematodes, Diseases, Weeds	Vapam**	470-900
	Vorlex Plus	225-450
	Vorlex Plus CP	220-440
	Busan 1020	470-900

\* Use higher rates for heavier soils, e.g. clay loams.

\*\* Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

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### CAUTION

Telone, Vapam, Vorlex and Busan are toxic to the applicator. Follow instructions regarding proper procedures for handling and application.

Always follow manufacturer's directions carefully concerning dosage and methods of use. A suitable respirator and protective clothing, etc., must be worn by the applicator. (See *Relative Toxicity to Applicator*, page 2.)

### Application of Fumigants

Land preparation is critical to effective fumigant application. See OMAFRA Factsheet *Land Preparation: A Key to Successful Soil Fumigation*, Order No. 89-177. Pre-plant fumigation is most effective if you take the following steps.

1. Fumigate in the fall when soil temperatures are above 4°C. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil.
2. Remove trash and old root systems. Work the soil to a depth of 25–30 cm and obtain good seedbed condition with regard to tilth and moisture.
3. Inject the fumigant about 30–40 cm deep.
4. Seal the soil surface by packing or watering immediately after injecting the fumigant.
5. Leave soil undisturbed until spring or, with fall planting, at least 1 week after injecting the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.
6. Work the soil and aerate for about a week before planting. For fall planting, aerate the soil at least 2 weeks after working.
7. Use high-quality planting stock grown preferably in fumigated soil.
8. Use Italian rye grass as an annual cover crop in cultivated orchards. Kentucky tall fescue, creeping red fescue, perennial ryegrass or annual ryegrass can be used as a permanent sod. These 3 grasses are poor hosts of the root-lesion nematode.

### Single Tree Sites for Replacement Trees

*Telone IIB, Vorlex Plus:* The procedure for pre-plant fumigation of single tree sites is the same as that described above, except that the fumigant is injected with a hand applicator (Fumigun) on 20 X 20 cm centres over a 2.5 X

2.5 m area. Rates per injection point are: Telone 0.8 mL; Vorlex Plus 0.2–0.5 mL (nematodes); Vorlex Plus 0.8–1.7 mL (nematodes, weeds, diseases). Fumiguns can usually be rented from custom applicators or pesticide dealers. Operators must wear protective equipment and clothing.

*Vapam:* Mix Vapam with water. Prepare the site and apply as a drench in the fall to individual replacement tree locations. For each replacement location, construct a circular basin in the soil — approximately 2 m across. While wearing protective equipment and clothing, add 0.3 L of Vapam to 90 L of water in a drum or tank. When solution is thoroughly agitated or mixed, apply it to each basin. This volume of solution is necessary for adequate penetration of the proposed root zone.

*Telone C-17-R:* Use Telone C-17 in climatic areas where fruit trees can be planted safely in the fall. However, you must allow a 3–6 month “aeration” period between soil treatment and tree planting. To avoid fumigant injury to the tree, prepare and treat the planting hole(s) in the spring, and plant the tree(s) the following fall.

Treat freshly prepared holes in the spring by pouring 0.8 L of Telone C-17-R uniformly over the bottom of each hole.

*Busan 1020:* After removing dead or diseased trees and as much of the root system as possible, make a shallow basin over the planting site. Add Busan 1020 to the stream of water while filling the basin. Use 1 L Busan 1020 per 10 m<sup>2</sup> in sufficient water (depending on soil type) to penetrate at least 2 m. For control of oak root fungus, use a basin at least 6 x 6 m. Increase dosage to 2 L Busan 1020 per 10 m<sup>2</sup> in sufficient water to penetrate to the depth of root system. If water is tanked to the planting site, add Busan 1020 to the water and mix before filling basin.

### VYDATE L — Post-Plant Treatment

#### CAUTION

Vydate L is toxic to humans. (See references to *Relative Toxicity to Applicator*, page 2 and *Blood Tests for Those Applying Pesticides*, page 3.) Follow instructions closely regarding proper procedures for handling and application.

### Non-Bearing Apples

Post-plant treatment of non-bearing apple trees for reduction of root-lesion nematode numbers can be achieved with oxamyl (Vydate L = 240 g active oxamyl/L). Apply a liquid-soil drench soon after planting. The liquid-soil drench is mixed at 1.25 L Vydate/1000 L water and applied at 3.5–10 L of the solution per tree, in a circle



around the base of the tree to cover the root zone. Do not use if air temperature is below 7°C, as Vydate is less effective at low temperatures. When leaves have expanded, apply a foliar application and repeat in 3–4 weeks. (Do not allow spray to drift on any trees in bloom). The foliar spray mix is 4.1–8.2 L Vydate/1000 L water applied at not over 9.3 L Vydate/ha in any 1 application. Sample the soil for nematodes in early September of the planting year to check on the need for further treatment.

For established non-bearing apple trees, apply the liquid soil drench early in April when buds are swelling. Apply a foliar spray before tight cluster and after petal fall.

Root absorption of Vydate occurs during periods of rapid shoot growth (early spring). Foliar absorption occurs best in young, rapidly expanding foliage. See the manufacturer's label for further details, precautions, and methods of application.

No soil-borne disease control should be expected with Vydate L. Post-plant treatments for nematode control are less effective than pre-plant soil fumigation. Post-bloom foliar sprays interfere with insect predators and are not recommended in orchards using integrated pest management.

### **Raspberries**

For reduction in the number of root-lesion nematodes, apply Vydate L as a liquid soil drench over the root zone.

Apply 1 application of Vydate L in the fall as a soil drench. Vydate is absorbed only by raspberry roots that are actively growing. Late application on dormant plants or when air temperature is below 7°C may not give satisfactory results.

Apply 9.35 L Vydate per hectare of treated soil area. If you are treating a 1.5 m wide strip, use 1.4 L of Vydate in 360 L of water on 1000 m of row.

Do not apply more than once during a 12-month period.

**Vydate is highly toxic to bees. Do not apply during the pink or bloom period.**

## **Wildlife Control**

### **Bird Damage and its Prevention in Fruit Crops**

Every year birds destroy large quantities of fruit in Ontario. Cherries, grapes, and blueberries are crops most subject to attack, but other fruit crops may also be damaged. Losses of 25% for sweet cherry and 10% for grape crops are not uncommon, although the extent of fruit damage varies greatly among varieties, location, and seasons. Pecking and puncturing damage is usually greater than actual losses from fruit consumed.

#### **Controls**

Start controls early and infrequently, 10 days prior to colouring of the crop when it becomes attractive to the birds. An integrated approach is the best method of bird control. Using several control methods provides a longer lasting effect. A complete description of bird biology and control tactics is available in OMAFRA Factsheet *Bird Control in Grape and Tender Fruit Farms*, Order No. 98-035.

#### **Methods of Bird Control**

The following discussion of certain drastic control measures does not imply their universal recommendation. In all cases, you must follow all local, provincial, and federal laws governing killing of birds, or the use of sound-scaring devices.

#### **Location**

Where you plant your commercial fruit crops can be an important factor in controlling birds. Cherry orchards and vineyards planted near a wooded area are particularly susceptible to damage, as birds find shelter and nesting sites close by. Similarly, small fruit plantings near hedges are particularly vulnerable.

#### **Physical Protection**

The only completely foolproof control method is to cover plants with netting. This physically prevents birds from getting the fruit. This method may be economically feasible for some grapes and highbush blueberries.

#### **Shooting**

Destruction of starlings and grackles is still a very practical control method. Normally shooting does not reduce the bird population, but it does frighten them out of the orchard. Law protects Robins and Northern orioles, but special permits may be obtained to kill them if you can show they are causing damage. Shells are also available with delayed explosions and/or sustained whistles that disorient and frighten the birds.

### CAUTION

Telone, Vapam, Vorlex and Busan are toxic to the applicator. Follow instructions regarding proper procedures for handling and application.

Always follow manufacturer's directions carefully concerning dosage and methods of use. A suitable respirator and protective clothing, etc., must be worn by the applicator. (See *Relative Toxicity to Applicator*, page 2.)

### Application of Fumigants

Land preparation is critical to effective fumigant application. See OMAFRA Factsheet *Land Preparation: A Key to Successful Soil Fumigation*, Order No. 89-177. Pre-plant fumigation is most effective if you take the following steps.

1. Fumigate in the fall when soil temperatures are above 4°C. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil.
2. Remove trash and old root systems. Work the soil to a depth of 25–30 cm and obtain good seedbed condition with regard to tilth and moisture.
3. Inject the fumigant about 30–40 cm deep.
4. Seal the soil surface by packing or watering immediately after injecting the fumigant.
5. Leave soil undisturbed until spring or, with fall planting, at least 1 week after injecting the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.
6. Work the soil and aerate for about a week before planting. For fall planting, aerate the soil at least 2 weeks after working.
7. Use high-quality planting stock grown preferably in fumigated soil.
8. Use Italian rye grass as an annual cover crop in cultivated orchards. Kentucky tall fescue, creeping red fescue, perennial ryegrass or annual ryegrass can be used as a permanent sod. These 3 grasses are poor hosts of the root-lesion nematode.

### Single Tree Sites for Replacement Trees

*Telone IIB, Vorlex Plus:* The procedure for pre-plant fumigation of single tree sites is the same as that described above, except that the fumigant is injected with a hand applicator (Fumigun) on 20 X 20 cm centres over a 2.5 X

2.5 m area. Rates per injection point are: Telone 0.8 mL; Vorlex Plus 0.2–0.5 mL (nematodes); Vorlex Plus 0.8–1.7 mL (nematodes, weeds, diseases). Fumiguns can usually be rented from custom applicators or pesticide dealers. Operators must wear protective equipment and clothing.

*Vapam:* Mix Vapam with water. Prepare the site and apply as a drench in the fall to individual replacement tree locations. For each replacement location, construct a circular basin in the soil — approximately 2 m across. While wearing protective equipment and clothing, add 0.3 L of Vapam to 90 L of water in a drum or tank. When solution is thoroughly agitated or mixed, apply it to each basin. This volume of solution is necessary for adequate penetration of the proposed root zone.

*Telone C-17-R:* Use Telone C-17 in climatic areas where fruit trees can be planted safely in the fall. However, you must allow a 3–6 month “aeration” period between soil treatment and tree planting. To avoid fumigant injury to the tree, prepare and treat the planting hole(s) in the spring, and plant the tree(s) the following fall.

Treat freshly prepared holes in the spring by pouring 0.8 L of Telone C-17-R uniformly over the bottom of each hole.

*Busan 1020:* After removing dead or diseased trees and as much of the root system as possible, make a shallow basin over the planting site. Add Busan 1020 to the stream of water while filling the basin. Use 1 L Busan 1020 per 10 m<sup>2</sup> in sufficient water (depending on soil type) to penetrate at least 2 m. For control of oak root fungus, use a basin at least 6 x 6 m. Increase dosage to 2 L Busan 1020 per 10 m<sup>2</sup> in sufficient water to penetrate to the depth of root system. If water is tanked to the planting site, add Busan 1020 to the water and mix before filling basin.

### VYDATE L — Post-Plant Treatment

#### CAUTION

Vydate L is toxic to humans. (See references to *Relative Toxicity to Applicator*, page 2 and *Blood Tests for Those Applying Pesticides*, page 3.) Follow instructions closely regarding proper procedures for handling and application.

### Non-Bearing Apples

Post-plant treatment of non-bearing apple trees for reduction of root-lesion nematode numbers can be achieved with oxamyl (Vydate L = 240 g active oxamyl/L). Apply a liquid–soil drench soon after planting. The liquid–soil drench is mixed at 1.25 L Vydate/1000 L water and applied at 3.5–10 L of the solution per tree, in a circle

around the base of the tree to cover the root zone. Do not use if air temperature is below 7°C, as Vydate is less effective at low temperatures. When leaves have expanded, apply a foliar application and repeat in 3–4 weeks. (Do not allow spray to drift on any trees in bloom). The foliar spray mix is 4.1–8.2 L Vydate/1000 L water applied at not over 9.3 L Vydate/ha in any 1 application. Sample the soil for nematodes in early September of the planting year to check on the need for further treatment.

For established non-bearing apple trees, apply the liquid soil drench early in April when buds are swelling. Apply a foliar spray before tight cluster and after petal fall.

Root absorption of Vydate occurs during periods of rapid shoot growth (early spring). Foliar absorption occurs best in young, rapidly expanding foliage. See the manufacturer's label for further details, precautions, and methods of application.

No soil-borne disease control should be expected with Vydate L. Post-plant treatments for nematode control are less effective than pre-plant soil fumigation. Post-bloom foliar sprays interfere with insect predators and are not recommended in orchards using integrated pest management.

### **Raspberries**

For reduction in the number of root-lesion nematodes, apply Vydate L as a liquid soil drench over the root zone.

Apply 1 application of Vydate L in the fall as a soil drench. Vydate is absorbed only by raspberry roots that are actively growing. Late application on dormant plants or when air temperature is below 7°C may not give satisfactory results.

Apply 9.35 L Vydate per hectare of treated soil area. If you are treating a 1.5 m wide strip, use 1.4 L of Vydate in 360 L of water on 1000 m of row.

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#### **Controls**

Start controls early and infrequently, 10 days prior to colouring of the crop when it becomes attractive to the birds. An integrated approach is the best method of bird control. Using several control methods provides a longer lasting effect. A complete description of bird biology and control tactics is available in OMAFRA Factsheet *Bird Control in Grape and Tender Fruit Farms*, Order No. 98-035.

#### **Methods of Bird Control**

The following discussion of certain drastic control measures does not imply their universal recommendation. In all cases, you must follow all local, provincial, and federal laws governing killing of birds, or the use of sound-scaring devices.

#### **Location**

Where you plant your commercial fruit crops can be an important factor in controlling birds. Cherry orchards and vineyards planted near a wooded area are particularly susceptible to damage, as birds find shelter and nesting sites close by. Similarly, small fruit plantings near hedges are particularly vulnerable.

#### **Physical Protection**

The only completely foolproof control method is to cover plants with netting. This physically prevents birds from getting the fruit. This method may be economically feasible for some grapes and highbush blueberries.

#### **Shooting**

Destruction of starlings and grackles is still a very practical control method. Normally shooting does not reduce the bird population, but it does frighten them out of the orchard. Law protects Robins and Northern orioles, but special permits may be obtained to kill them if you can show they are causing damage. Shells are also available with delayed explosions and/or sustained whistles that disorient and frighten the birds.

### **Automatic Exploders**

One of the most commonly used bird controls is the automatic exploder. This is a propane-powered cannon set to produce a loud gunshot-like sound at specified intervals. Many birds soon become accustomed to these cannons and are sometimes observed perched fearlessly near the device while it explodes. Automatic exploders are particularly effective when used in conjunction with shooting.

Next to shooting, these noise-producing devices are the most effective method that is presently commercially available for control. However, the element of surprise and uncertainty plays a big part in disrupting the birds. Regular movement of the devices to different locations in the orchard or vineyard is very important. Birds quickly adjust their feeding habits if the scaring device is left in the same location throughout the harvest season.

A major drawback of these devices is the disruption to your neighbours' quality of life. Growers must recognize this fact and adjust the use of this equipment to cause the least discomfort to those around them.

### **Electronic Sound Devices**

This equipment sends out an electronic sound that imitates distress or predator calls of different bird species, causing birds to move out of an orchard after 1 or 2 days of exposure. Electronic sound devices have been effective in reducing bird damage to sweet and sour cherries, grapes, and other fruit crops.

### **Chemical Controls**

There are currently no chemicals registered for use in Ontario to control birds in fruit crops. It is illegal to use unregistered chemicals on any food crops.

### **Visual Deterrents**

Other control methods that have been tried include: aluminum foil hung in trees, model hawks, strips of yellow plastic hung across vineyards, vibrating plastic strips, scarecrows, and scare-eye balloons. Visual deterrents move with the wind, producing noise and making reflections. These have provided only limited control.

### **Falconry**

Trained falcons and hawks have been used successfully for many years at airports. Experienced falconers are needed to fly the birds. Availability, cost and time are major drawbacks for fruit growers.

### **Rodent and Deer Control in Orchards**

Control of rodents and deer is most effective when it is part of a season-long management strategy involving good san-

itation and cultural and chemical control methods. A complete description of the pest biology and control tactics is available in OMAFRA Factsheet, *Rodent and Deer Control in Orchards*, Order No. 98-023. Also see the new Publication 10, *Deer Control Practices in Agriculture*.

### **Bait for Mouse and Vole Control**

*Zinc phosphide-treated baits* — Several products are available. Generally the rates of application are between 4.5–9 kg/ha, depending on the severity of infestation. If further mouse activity is detected, repeat the treatment when rain is not expected.

*Diphacinone (Ramik Brown)* — 22 kg/ha in 2 applications of 11 kg each. Applications can be made 20–40 days apart.

*Chlorophacinone (Rozol, Groundforce)* — Apply 11–11.25 kg/ha and repeat in 20–60 days where infestation is high.

### **Wrapping Young Trees**

Wrap sacking about the top and the trunk above the mouse guard to protect young trees from rabbits. Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when the snow is deep.

### **Repellents**

**Taste repellents:** Rabbits do not like to feed on the trunks of young trees if the trees have been treated with thiram. There are a number of commercial mixtures available, some of which mix white latex paint with thiram. Be sure to treat the tree as high as rabbits can reach when standing on deep snow.

For more information refer to *Control of South West Injury on Fruit Trees*, page 33 and OMAFRA Factsheet *Rodent and Deer Control in Orchards*, Order No. 98-023.

**Scent repellents:** Fruit trees, bushes, and plants treated with Hinder can be less susceptible to browsing injury from deer and rabbits. The active ingredient of Hinder is ammonia soaps of the higher fatty acids.

Re-treatment may be necessary after heavy rainfall. Hinder is reported to be more effective when used during warm temperatures.

Hinder may be applied to the following food crop plants up to 14 days before harvest:



- for apples, blueberries, cherries, peaches, pears, plums, and raspberries, apply 3–5 L of product/100 L of water
- for strawberries, apply 2–4 L product/100 L of water. Apply 450–950 L of spray solution/hectare.

### **Deer Removal Permit Program**

You must have a permit to shoot deer in defense of property. Contact the local Ministry of Natural Resources (MNR) office for an evaluation and action plan. Action depends on the severity of damage, the level of previous control attempts and a reasonable expectation of controlling the problem deer.

The MNR area supervisor or Enforcement Supervisor issues permits to farmers or their agents in order to kill white-tail deer in defense of property under Section 2.1 of the *Game and Fish Act*.

Before a deer removal permit is issued, the following conditions must be satisfied.

- Deer damage is evaluated as economically significant by the evaluator. A written report must be filed reflecting the extent (percent of crop) and associated dollar value.
- The farmer permits licensed deer hunters on the property during open season (if any); the farmer has made reasonable attempts to control deer using deterrents or by modifying farm management practices. This should be documented and kept with the deer removal permit file.
- Appropriate arrangements for the disposition of the carcass have been established.

Refer to Publication 10, *Deer Control Practices in Agriculture*, a new book from OMAFRA and MNR, for other ways to control deer.

### **Repairing Damage by Mice and Rabbits**

Carry out regular inspection throughout the winter to check for injury. Mice often work just below the surface of the snow or in the litter. If a tree has been wholly or partially girdled, give it first aid immediately. Cover the wound with a grafting compound or wound dressing.

Before the buds swell in the early spring, secure scions that are long enough to bridge the wound. See OMAFRA Fact-sheet *Repair Grafting*, Order No. 98-003. Store the scions in damp sand or sawdust in a cool place. If the wound extends for more than one quarter of the circumference of the trunk, bridge graft in the manner described in *Repair Grafting*. Grafting should be done when the bark slips rap-

idly from the wood (about bloom). Repair grafting is not practical on trees with a diameter less than 10 cm. Instead, replace small trees.

## **Control of Southwest Injury on Fruit Trees**

Southwest injury (winter sunscald) occurs during the winter and is especially severe when cold, sunny days are followed by cold, clear nights. This phenomenon can occur in apple, peach, pear, cherry, plum and apricot orchards. Injuries are usually confined to the south and southwest sides of the trunks and main scaffold branches. On sunny days these tissues become considerably warmer than the surrounding air and at night they cool rapidly. Under these conditions, freezing of the bark may occur. Freezing injury usually affects large portions of the bark tissue that becomes brown and eventually sloughs off as healing occurs beneath.

In stone fruit orchards, these injuries provide ideal sites for infection by the peach canker or other canker diseases. The combined effect of southwest injury and peach canker greatly reduces the productive life of affected trees.

Painting the trunk, crotches, and lower parts of main scaffold branches with exterior white latex paint can prevent southwest injury. The white paint reflects the sunlight and prevents the tissues exposed to direct sunshine from rapid thawing on cold days when air temperatures are below freezing. Rapid thawing in the day and freezing at night is prevented by the paint and freezing injury is reduced.

**Do not use oil-based paints or latex paints that contain some oil. These products contain toxic materials that may injure or kill fruit trees.**

October is the best time to apply the paint. Best results are obtained when trees are painted on days when the temperature is above 10°C and conditions favour rapid drying. Apply the paint by brush or by spray. When spraying, use 1–2 L of water/4.5 L of paint, depending on the thickness of the paint and the air pressure available. On young trees, paint the whole trunk, but on older trees only the south and southwest sides of the trees require painting. The whiter the bark after painting, the greater the protection. Better quality paints are more durable.

On young trees, injury from rodents may be a greater problem than southwest injury. To obtain protection from both problems, use commercially available thiram-latex



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## **IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES**

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**USERS SHOULD CONSULT ALL THE PAGES  
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D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL**

mixtures such as Skoot and Ropellant. Thiram acts as a taste repellent for rodents and helps prevent infection by peach canker. This mixture may also be used effectively as a wound dressing.

Do not use the thiram-latex mixture if you plan on using a fall Bordeaux spray program. The thiram reacts with the Bordeaux spray, changing the colour of the paint from white to brown, and reducing its effectiveness as a heat reflectant. The Bordeaux spray does not affect trees painted with latex only and can be used when thiram is excluded from the mixture. If the thiram-latex mixture is planned as a combined rodent repellent and protectant from south-west injury, then you must paint the whole trunk. Good coverage at the soil line is very important to prevent mouse damage.

## Use of Copper Products on Fruit Crops

### Chemical Characteristics of Copper Fungicides

Copper mixtures have long been recognized as having fungicidal properties. Historically, Bordeaux mixture was the main copper fungicide. It was made by mixing bluestone (a raw form of copper sulfate) and hydrated lime. The free copper ions provide most of the activity that copper mixtures have on fungal and bacterial diseases. This free copper can also be toxic to plants, causing burning of leaves, and burning or scarring of fruit. Bordeaux mixtures are considered unsafe after "1/4 inch green" on most fruit crops. Check the product label for use patterns and timings for each crop.

"Fixed copper" collectively describes a group of copper formulations containing complex copper sulfates, copper oxychlorides, and copper oxides. Fixed copper compounds are easier to handle than Bordeaux, are equal in effectiveness to Bordeaux — except they do not adhere or persist as well — and are generally less phytotoxic and less corrosive than Bordeaux. These new copper formulations have a small particle size and have added materials to improve spreading and sticking qualities.

### Procedures To Tank-Mix Copper Formulations and Lime

Some fixed copper labels suggest mixing the copper with lime. If you have problems mixing fixed coppers with lime, consider the following instructions:

1. Start water flowing into the spray tank.
2. When the tank is about 1/3rd full and the mechanical agitator is operating, start washing the powdered copper product into the tank through a screen with water from the supply hose. Use a wooden spoon to help work the copper product through the screen. The screen prevents large granules of copper (especially if opened product has gotten wet, then dried) from getting into the tank. Pre-mixing copper product with hot water also helps the product dissolve.
3. Put all of the powdered copper sulfate in the tank by the time the tank is two-thirds full. Then wash the lime (use hydrated or builder's lime) through the screen into the copper solution in the tank. Use the water from the supply hose. Use lots of water to dilute the lime as much as possible before it meets the copper solution. Pre-soaking the lime before adding to the tank may be preferable to washing powdered lime directly through the screen into the tank.
4. Keep the agitator running continuously and apply the copper mixture immediately. Do not allow the mixture to settle out.

### Registration Status and Availability of Copper Fungicide Products

It is important to use only copper products that have a federal label with a PCP number. The PCP number indicates a product that has been approved as a crop protection product for application on agricultural crops. Presently, there are 5 copper products that have PCP numbers and possess a federal registration. For a summary of labeled products and crop uses consult Table 4-3, *Copper Products for Use on Fruit Crops in Ontario*.

**The copper product known as "Noranda superfine bluestone" is no longer registered for use on agricultural crops for the purpose of crop protection.**

**TABLE 4-3. Copper Products for Use on Fruit Crops in Ontario\***

Category	Registered Copper Products				
Product Name	Clean Crop Copper 53W	Griffin Basicop	Guardaman copper oxychloride 50	Clean Crop Copper Spray	Triangular Brand Copper Sulfate
PCP Registration No.	9934	19003	13245	19146	24034
Ontario Classification	Schedule 2	Schedule 3	Schedule 2	Schedule 3	Schedule 3
Active Ingredient	Copper from tribasic copper sulfate 53%	Copper in basic copper sulfate 53% by weight	copper from copper oxychloride 50%	copper from copper oxychloride 50%	cupric sulphate pentahydrate (metallic copper 25.2%)
APPLES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 1 kg 6 kg	×	×	×	✓ 2 kg 6 kg
APRICOTS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	×	×	×	×	×
BLACKBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	×	×	×	×	×
BLUEBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	×	×	✓ 2-4 kg no lime required	✓ 2-4 kg no lime required	×
CURRENTS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 3-5 kg 4 kg	✓ 3-5.5 kg 4 kg	×	×	×
FILBERTS HAZELNUTS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	×	×	✓ 3-9 kg/ha no lime required	✓ 3-9 kg/a no lime required	×
GOOSEBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 3-5 kg 4 kg	✓ 3-5.5 kg 4 kg	×	×	×
GRAPES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 3 kg 6 kg	✓ 3 kg 6 kg	✓ 3 kg 6 kg	✓ 3 kg 6 kg	×
PEACHES/NECTARINES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 4 kg no lime required	✓ 4 kg no lime required	×	✓ 2 kg no lime required	×
PEARS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 1 kg 6 kg	×	×	×	✓ 2 kg 6 kg

<sup>1</sup> rate is expressed kg/1000 L of water unless otherwise stated. To calculate rate per ha see Table 2-1, *Tree Row Volume* guidelines, page 13 and Chapter 2, *Pesticide Application*. Also check label for maximum rate per ha.

\* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 1999.

✓ registered in Ontario

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mixtures such as Skoot and Ropellant. Thiram acts as a taste repellent for rodents and helps prevent infection by peach canker. This mixture may also be used effectively as a wound dressing.

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<b>APPLES</b>					
registration status	✓	✗	✗	✗	✓
rate of formulated copper <sup>1</sup>	1 kg				2 kg
rate of hydrated lime	6 kg				6 kg
<b>APRICOTS</b>					
registration status	✗	✗	✗	✗	✗
rate of formulated copper <sup>1</sup>					
rate of hydrated lime					
<b>BLACKBERRIES</b>					
registration status	✗	✗	✗	✗	✗
rate of formulated copper <sup>1</sup>					
rate of hydrated lime					
<b>BLUEBERRIES</b>					
registration status	✗	✗	✓	✓	✗
rate of formulated copper <sup>1</sup>			2-4 kg	2-4 kg	
rate of hydrated lime			no lime required	no lime required	
<b>CURRENTS</b>					
registration status	✓	✓	✗	✗	✗
rate of formulated copper <sup>1</sup>	3-5 kg	3-5.5 kg			
rate of hydrated lime	4 kg	4 kg			
<b>FILBERTS</b>					
<b>HAZELNUTS</b>					
registration status	✗	✗	✓	✓	✗
rate of formulated copper <sup>1</sup>			3-9 kg/ha	3-9 kg/a	
rate of hydrated lime			no lime required	no lime required	
<b>GOOSEBERRIES</b>					
registration status	✓	✓	✗	✗	✗
rate of formulated copper <sup>1</sup>	3-5 kg	3-5.5 kg			
rate of hydrated lime	4 kg	4 kg			
<b>GRAPES</b>					
registration status	✓	✓	✓	✓	✗
rate of formulated copper <sup>1</sup>	3 kg	3 kg	3 kg	3 kg	
rate of hydrated lime	6 kg	6 kg	6 kg	6 kg	
<b>PEACHES/NECTARINES</b>					
registration status	✓	✓	✗	✓	✗
rate of formulated copper <sup>1</sup>	4 kg	4 kg		2 kg	
rate of hydrated lime	no lime required	no lime required		no lime required	
<b>PEARS</b>					
registration status	✓	✗	✗	✗	✓
rate of formulated copper <sup>1</sup>	1 kg				2 kg
rate of hydrated lime	6 kg				6 kg

<sup>1</sup> rate is expressed kg/1000 L of water unless otherwise stated. To calculate rate per ha see Table 2-1, *Tree Row Volume* guidelines, page 13 and Chapter 2, *Pesticide Application*. Also check label for maximum rate per ha.

\* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 1999.

✓ registered in Ontario

✗ not registered





TABLE 4-3. Copper Products for Use on Fruit Crops in Ontario\* (cont'd)

Category	Registered Copper Products				
Product Name	Clean Crop Copper 53W	Griffin Basicop	Guardsman copper oxychloride 50	Clean Crop Copper Spray	Triangular Brand Copper Sulfate
PCP Registration No.	9934	19003	13245	19146	24034
Ontario Classification	Schedule 2	Schedule 3	Schedule 2	Schedule 3	Schedule 3
Active Ingredient	Copper from tribasic copper sulfate 53%	Copper in basic copper sulfate 53% by weight	copper from copper oxychloride 50%	copper from copper oxychloride 50%	cupric sulphate pentahydrate (metallic copper 25.2%)
PLUMS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	x	x	x	x	x
RASPBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 4 kg no lime required	✓ 4 kg no lime required	✓ 2.5-3.0 kg no lime required	✓ 2.5 kg no lime required	x
SOUR CHERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 2 kg 4 kg	✓ 2 kg no lime required	✓ 2 kg 4 kg	✓ 2 kg 4 kg	x
SWEET CHERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	x	x	x	x	x
STRAWBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 2.5-3.8 kg per ha no lime required	✓ 2.3-3.8 kg per ha no lime required	x	x	x
WALNUTS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	x	x	x	✓ 4 kg/ha no lime required	x

<sup>1</sup> rate is expressed kg/1000 L of water unless otherwise stated. To calculate rate per ha see Table 2-1, *Tree Row Volume* guidelines, page 13 and Chapter 2, *Pesticide Application*. Also check label for maximum rate per ha.

\* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 1999.

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PLUMS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	x	x	x	x	x
RASPBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 4 kg no lime required	✓ 4 kg no lime required	✓ 2.5-3.0 kg no lime required	✓ 2.5 kg no lime required	x
SOUR CHERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 2 kg 4 kg	✓ 2 kg no lime required	✓ 2 kg 4 kg	✓ 2 kg 4 kg	x
SWEET CHERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	x	x	x	x	x
STRAWBERRIES registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	✓ 2.5-3.8 kg per ha no lime required	✓ 2.3-3.8 kg per ha no lime required	x	x	x
WALNUTS registration status rate of formulated copper <sup>1</sup> rate of hydrated lime	x	x	x	✓ 4 kg/ha no lime required	x

<sup>1</sup> rate is expressed kg/1000 L of water unless otherwise stated. To calculate rate per ha see Table 2-1, *Tree Row Volume* guidelines, page 13 and Chapter 2, *Pesticide Application*. Also check label for maximum rate per ha.

\* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 1999.

✓ registered in Ontario

x not registered

# 5. Ground Cover Management

## Adaptation and Use of Cover Crops

Cover crops can take several different forms and are used for very different purposes. They can be used as:

- green manure, for soil organic matter and structure building
- a true cover crop for overwinter protection of the soil or
- a ground cover.

The sod ground covers used in tree fruits, grapes and some berries can be temporary, permanent or a combination. Below is information on some of the more commonly-used cover or green manure crops.

### Grasses

Grasses have fine, fibrous root systems that are well suited to holding soil in place and improving soil structure. Suitable grass species for cover crops are fast growing and relatively easy to kill — either chemically, mechanically or by winter weather. Grasses do not fix any nitrogen out of the atmosphere, but they can accumulate large quantities from the soil.

### Spring Cereals

Oats and barley are commonly used as green manure and cover crops. Stands seeded between mid-August to mid-September will have 20–40 cm of growth by freeze-up. The stand is generally killed by late, hard frosts. While seeding can be done outside this time frame, heat and lack of moisture in the summer may interfere with germination.

**Cautions:** Early seeding may result in considerable growth by freeze-up. This can form a mat of dead residue if left untilled. In the spring, this can keep soil cold and wet, interfering with spring tillage.

### Winter Wheat

Winter wheat can be seeded in late August through October. It can be seeded outside this time but, similar to spring cereals, weather conditions may reduce top growth. Wheat survives overwinter and begins growing in April. The stand can be killed through tillage or herbicide application. The plant shuts down earlier in fall and begins to grow later in the spring.

**Cautions:** Generally winter wheat does not return as much green material to the soil as rye, nor does it give the level of weed competition that rye provides.

### Sorghum Sudan

Sorghum sudan is an excellent choice for growing as a green manure crop to improve the soil. Root growth is extensive and top growth lush. A pre-plant herbicide treatment is recommended for crop establishment. Plant in mid-June, after all threat of frost is past. The crop benefits from the warm temperatures of early to mid summer. Approximately 50 kg/ha of N helps the crop achieve maximum top growth.

**Cautions:** Mow sorghum sudan before it reaches 1 m in height. This encourages tillering and ensures stalks are not woody, thus allowing break down readily.

### Winter Rye

Winter rye is seeded from late August to mid-October, often following field or vegetable crops. It grows until freeze-up, and then begins growth again in March to early April (slightly earlier than winter wheat). Growth rate is very rapid during May. The stand is generally killed in late April or early May by tillage or herbicide use. Rye can produce significant root and top mass for return to the soil. A rye cover crop suppresses winter annual weeds effectively. Winter rye can be seeded later than any other crop and still survive over winter. For good ground cover and erosion protection, seed at least a month before freeze-up.

**Cautions:** Kill rye in the fall or early spring to avoid loss of soil moisture, and difficulties in incorporation. Full season rye is an excellent host for root-lesion nematode, while cover crop or short term rye is no different than wheat.

### Legumes

Legume cover crops can fix nitrogen from the air, supplying nitrogen to the succeeding crop as well as protecting the soil from erosion and adding organic matter. The amount of nitrogen fixed varies between species, although generally, more top growth equals more nitrogen fixed. Some legume species have aggressive tap roots that can

break up subsoil compaction, but this requires more than one year's growth to happen.

Legumes are not commonly used as cover crops for fruit crop production because they provide an inconsistent and season-long release of nitrogen. Too much nitrogen at the wrong timing can interfere with fruit quality and winter hardiness of fruit crops. Legumes may flower at the same time as fruit crops and cause competition for bees and other pollinators. Legumes are also attractive to tarnished plant bugs and most are excellent hosts for nematodes. Legume cover crop species are covered in the OMAFRA Publication 296, *Field Crop Recommendations*.

### **Non-Legume Broadleaves**

These broadleaf crops may have a role as green manure crops and in providing different plant species and root systems for soil building. They cannot fix nitrogen out of the air, but they can absorb large quantities from the soil. Neither of these crops are winter-hardy, so additional control measures are not normally required. Do not allow them to go to seed, as the volunteer seed can become a significant weed problem.

#### ***Buckwheat***

As a cover crop, buckwheat is most commonly seeded in late June to early August. It grows very rapidly, reaching flower stage and a height of 45–75 cm in about 6 weeks. It has a relatively small fibrous root system and is completely killed by the first frost. Buckwheat provides rapid soil cover, gives good erosion protection during the growing season, smothers annual weeds and suppresses perennial ones. Moderate amounts of fresh organic matter are returned to the soil.

**Cautions:** Late summer seedings may be killed by an early frost before providing significant growth. Buckwheat is an excellent host for root-lesion nematode.

#### ***Oilseed Radish***

Oilseed radish is commonly seeded in August or early September. It is unaffected by early frosts, can grow to a height of 50 cm in October. The plant has a thick, but short taproot, varying between carrot and turnip shaped. It is killed by severe frosts in late November or December. Oilseed radish provides a reasonably rapid soil cover and excellent erosion protection over winter. It returns moderate amounts of organic matter to the soil. For good growth, this crop must have a large amount of available nitrogen, either applied as fertilizer or residue left from a previous crop. Some oilseed radish varieties release compounds

toxic to nematodes, but only when large amounts are tilled green into the soil.

**Cautions:** Growth will be poor if soil nitrogen levels are low or if soil compaction is severe. Scattered volunteer plants usually appear in most crops planted after oilseed radish.

## **Sod Covers for Orchards, Vineyards and Brambles**

One of the best ways of protecting and supplying organic matter, controlling erosion and reducing late season growth, is using a cover crop. There are 2 approaches to cover crops; one temporary; the other permanent.

### **Temporary**

A temporary cover crop is seeded late in the season. Stop cultivation by June 1 in peach orchards, July 1 in other orchards and cane fruit plantings, and by August 1 in vineyards. A cover crop such as annual Italian rye grass can then be seeded at the rate of 13–17 kg/ha. Use a soil test to determine optimum fertilizer rates or fertilize with 100 kg/ha 10–20–20 before seeding to promote growth and organic matter production. This crop is incorporated into the soil early next spring.

### **Permanent**

For permanent sod covers, many different species of grass can be used. Choose a grass that is:

- not overly vigorous
- resistant to traffic damage in early spring and late fall
- drought resistant
- not a good habitat for voles and mice.

Short growing turf-type fescues (tall or creeping red) make excellent sods and also offer some suppression of nematodes. To aid germination, seed as shallow as possible at the rate of 20–22 kg/ha in later August or September. Prepare and fertilize the soil well, according to soil test results or with 100 kg/ha 10–20–20 before seeding. Sod mixtures containing grasses and legumes can also be used, but inclusion of forage legumes may result in the untimely release of nitrogen and concerns with pest management.

Use permanent sod covers in stone fruit orchards only where irrigation is available.



TABLE 5-1. Characteristics of Green Manure Crops and Cover Crops Grown in Ontario

Species	Normal Seeding Time	Seeding Rate kg/ha	Nitrogen Fixed	Overwintering characteristics	Potential Weed Problem from Volunteer Seed	Supports Nematodes <sup>1</sup>	
						Lesion	Root-knot
<b>Grasses</b>							
Spring cereal	Mid-Aug.–Sept.	100–125	no	killed by heavy frost	no	+	–
Sorghum sudan	June–Aug.	50	no	killed by frost	no	0	–
Winter wheat	Sept.–Oct.	100–125	no	overwinter well	no	+	–
Winter rye	Sept.–Oct.	100–125	no	overwinters very well	no	+ <sup>2</sup>	–
<b>Legumes</b>	April–June	species dependent	yes	most overwinter	usually not	0 to +++	0 to +++
<b>Non-legume broadleaves</b>							
Oilseed radish	Mid-Aug.–early Sept.	10–14	no <sup>3</sup>	killed by heavy frost	yes	0	0
Buckwheat	June–Aug.	50–60	no	killed by first frost	yes	+++	0

<sup>1</sup> Varietal differences in cover crop species may affect nematode reaction

<sup>2</sup> Rye — whole season rating would be higher (+++)

<sup>3</sup> Oilseed radish does not fix nitrogen from the air, but is a strong accumulator of nitrogen from soil and manure applications.

NEMATODE RATING CODES: (–) poor or non-host; (+) ability to host; (0) some cultivars are non-hosts



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<b>Legumes</b>	April–June	species dependent	yes	most overwinter	usually not	0 to +++	0 to +++
<b>Non-legume broadleaves</b>							
Oilseed radish	Mid–Aug.–early Sept.	10–14	no <sup>3</sup>	killed by heavy frost	yes	0	0
Buckwheat	June–Aug.	50–60	no	killed by first frost	yes	+++	0

<sup>1</sup> Varietal differences in cover crop species may affect nematode reaction

<sup>2</sup> Rye — whole season rating would be higher (+++)

<sup>3</sup> Oilseed radish does not fix nitrogen from the air, but is a strong accumulator of nitrogen from soil and manure applications.

NEMATODE RATING CODES: (–) poor or non-host; (+) ability to host; (0) some cultivars are non-hosts

# 6. Pollination and Bee Poisoning Prevention

## Pollination Requirements for Fruit Crops

Most fruit crops benefit from or require insect pollination.

### **Apples**

Apple cultivars grown in Ontario do not generally set fruit with their own pollen. For this reason, 2 or more compatible cultivars must be planted together in the orchard to enable cross-pollination and fruitfulness. Good pollen movement is necessary for high seed count fruit.

### **Apricots**

Most varieties are self-fruitful and may be planted in solid blocks. Because apricots bloom early when the weather is unreliable, provide honey bees to help with pollen transfer.

### **Blueberries**

Blueberries are self-fruitful and may be planted in solid blocks. However, cross-pollination of cultivated blueberries can give larger berries, higher yields and somewhat earlier ripening. It is advisable to plant more than 1 blueberry variety. Honey bees help with pollination.

### **Sour Cherries**

Sour cherries are self-fruitful and do not require pollinizer cultivars for a commercial crop. For maximum production of sour cherries, use honey bees at a rate of 2 strong hives per hectare. Sour cherries and sweet cherries are different species, and will not pollinate each other.

### **Sweet Cherries**

Sweet cherries are not pollinated by wind; the honey bee — use 2 hives/ha — is the only effective pollinating insect reported. Many sweet cherry cultivars are self-unfruitful and must not be planted in solid blocks. Certain groups of cultivars will not pollinate each other. Careful attention to planting arrangement of sweet cherries is required. Recent sweet cherry cultivar introductions from the Vineland breeding program are self compatible.

### **Currants and Gooseberries**

These are self-fruitful, but insects assist in pollen transfer. Honey bees can increase crop yield.

### **Grapes**

All commercial varieties of grapes are self-fruitful and are pollinated by wind. It is not necessary to provide honey bees for pollination.

### **Peaches and Nectarines**

All commercial varieties grown in Ontario are self-fruitful and may be planted in solid blocks. Honey bees readily work peach blossoms and frequently cause a heavy set, resulting in extra thinning costs. For this reason, do not put bee hives in peach orchards.

### **Pears**

All varieties in Ontario are self-unfruitful. Mixed plantings are necessary. Insects are required for cross-pollination. Honey bees do not find pear blossoms as attractive as most other fruit. Careful timing of the introduction of honey bees to orchards is necessary. Place up to 8 strong hives/ha when the orchard is about 25% in bloom. Use pollen inserts to help overcome pollination problems.

### **Plums**

Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honey bees readily work plum blossoms.

### **Raspberries and Blackberries**

Raspberries are self-fruitful. Their bloom is very attractive to bees.

### **Strawberries**

Strawberries are self-fruitful, and are pollinated by gravity, wind, and insect transfer. Pollination by honey bees or other insect pollinators may improve berry size and shape.

### **Tree Nut Crops**

These rely on cross pollination achieved mainly by wind action.

## Using Honey Bees Effectively

The primary domesticated insect pollinator of cultivated crops is the honey bee. Many growers facilitate the pollina-

tion process by arranging to have beekeepers move honey bee colonies into their crops during the blooming period. The following information will help you use honey bees more efficiently.

- Obtain honey bees from a reliable beekeeper able to supply strong, healthy colonies. Weak colonies are of little value for early spring pollination when cool weather is often encountered.
- Two to 3 colonies of honey bees per hectare should provide satisfactory pollination. However colony stocking rates vary depending on the type of fruit, the variety and the planting density. In young orchards fewer honey bee colonies may be required because there are generally fewer blossoms to pollinate. On the other hand, for early blooming fruit crops such as apricots, cherries and plums, you are better off to use more honey bee colonies than the recommended stocking rates indicate. This precaution should compensate for the negative affect of cold weather, which often occurs during the pollination period of these crops.
- A pollen insert is a device inserted into the entrance of a honey bee colony that forces bees leaving the hive to crawl through a shallow tray containing pollen from the desired pollinizer. Sufficient pollen will usually adhere to the legs and body of each foraging bee to enable it to cross-pollinate the blossoms it visits.
- When using a pollen insert, place colonies in the crop after blossoms have partially opened (earlier for sweet cherries, later for pears). This encourages more bees to work the fruit blossoms in the immediate surroundings, rather than foraging elsewhere. This recommendation is extremely important to ensure the effective use of pollen inserts. Have 5 colonies per hectare when using pollen inserts.
- There is often cool weather during the pollination period for early blooming fruit crops. To encourage maximum honey bee flight during cool weather, protect the colonies from cold spring winds. Place the colonies in larger groupings in sunny, sheltered locations. Where there is no natural windbreak, erect a temporary wind shelter using, for example, bales of straw. Place the colonies so that the morning sunshine strikes the hive entrances.
- Pollination by honey bees and the use of pollen inserts will not improve the harvested crop in orchards suffering from nutritional deficiencies, insect or disease problems, poor drainage, or other adverse conditions.

- Provide water to colonies during bloom periods that are exceptionally dry. A shallow tub of water with floating sticks allows bees to land without drowning. Bees will abandon pollen collection in favour of securing water for the colony.

For information contact either the provincial apiarist at (519) 826-3595 or by email at [dmcroty@omafra.gov.on.ca](mailto:dmcroty@omafra.gov.on.ca).

### Recommended Publications

For more information on pollination requirements of fruit crops, refer to OMAFRA Publication 430, *Fruit Cultivars, A Guide to Commercial Growers*.

For more information on management of honey bees, see *A Guide to Managing Bees for Crop Pollination*, Canadian Association of Professional Apiculturists. Order from Department of Environmental Biology, University of Guelph, Guelph, Ontario, N1G 2W1. Phone (519) 824-4120 ext. 2477, or ext. 3565 or fax (519) 837-0442 or email: [csdupree@evbhort.uoguelph.ca](mailto:csdupree@evbhort.uoguelph.ca).

### Bee Poisoning

Bees are essential for the pollination of most tree and small fruits. Insecticides, many of which kill bees, are required for insect control. With careful management, you can obtain both pollination and insect control. You can protect the bees by following these suggestions.

- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Read label for guidelines.
- Time of treatment is important. In general, daytime treatments, when bees are foraging in the field, are most hazardous. Insecticide applications in the very early morning are safest. Evening is the next best time.
- Remove honey bee colonies as soon as pollination is complete and before any post-bloom insecticides are applied.
- If there is a risk of honey bee poisoning, try to choose an insecticide that is not highly toxic to the bees.
- Honey bees frequently are poisoned by visiting cover crops, such as dandelions or clovers, that are in bloom in the orchard. Clipping or beating down such crops prior to spraying will help safeguard the bees.



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The following groups (chemicals used with fruit crops) show the relative toxicity of pesticides to honey bees as determined by laboratory and field tests.

**Group I — Pesticides Highly Toxic to Bees**

Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter:

Admire, Agri-mek, Ambush, APM, Cygon, Cymbush, Decis, Diazinon, Furadan, Guthion, Imidan, Lorsban, Malathion, Matador, Parathion, Pounce, Pyramite, Ripcord, Sevin, Sniper, Vydate

**Group II — Pesticides Moderately Toxic to Bees**

These can be used around bees if dosage, timing, and method of application are correct, but do not apply them directly on bees, in the field or at the colonies:

Carzol, Dikar, Endosulfan, Lannate, Metasystox, Nustar, Pirimor, Thiodan, Zolone

**Group III — Pesticides Relatively Non-Toxic to Bees**

Aliette, Apollo, Benlate, Botran, Bordeaux, Bravo, Captan, Confirm, Copper, Dipel, Dithane, Dýrene, Elevate, Equal, Ferbam, Folpan, Foray, Funginex, Kelthane, Kumulus, Manzate, Maestro, Mitac, Morestan, Nova, Penncozeb, Polyram, Ridomil, Ronilan, Rovral, Senator, Streptomycin, Sulphur, Topas, Vangard, Zineb

For more detailed information on the toxicity of specific pesticides to honey bees refer to the pesticide label.

**Extremely Toxic to Bees**

***Furadan***

This insecticide has caused more loss (confirmed cases of poisoning) to bees in Ontario than any other of the materials mentioned in this publication. Fruit growers and apiarists require close liaison when and where Furadan is used.

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Carzol, Dikar, Endosulfan, Lannate, Metasystox, Nustar, Pirimor, Thiodan, Zolone

**Group III — Pesticides Relatively Non-Toxic to Bees**

Aliette, Apollo, Benlate, Botran, Bordeaux, Bravo, Captan, Confirm, Copper, Dipel, Dithane, Dyrene, Elevate, Equal, Ferbam, Folpan, Foray, Funginex, Kelthane, Kumulus, Manzate, Maestro, Mitac, Morestan, Nova, Penncozeb, Polyram, Ridomil, Ronilan, Rovral, Senator, Streptomycin, Sulphur, Topas, Vangard, Zineb

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# 7. Apples

FIGURE 7-1. Apple Growth Stages\*



Dormant

Silver Tip

Green Tip

Half-Inch Green



Tight Cluster

Early Pink

Pink

Bloom



Petal Fall

Fruit Set

Terminal Growth

Regrowth

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# Apple Nutrition

Soil preparation and soil testing before planting trees is important. To ensure long term productivity of this perennial crop, prepare the soil through tillage and additions of organic matter well in advance of planting. For information on building and maintaining soil organic matter see *Managing Soil Organic Matter*, page 20 and *Manure for Orchards*, below.

Prior to planting, ensure nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to Table 7-2, *Phosphorus and Potassium Soil Requirements Before Planting Apples*, page 45. Phosphorus, potassium and lime do not move readily through the soil and pre-plant applications are the most effective.

## Manure for Orchards

Animal manure contains varying levels of nutrients and organic matter. The disadvantage of adding manure to orchards is that the nitrogen is released over a prolonged period of time. This slow release means this perennial crop continues to receive nitrogen throughout the year, resulting in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue. This makes trees more susceptible to winter injury.

The practice of putting manure around newly planted trees is not recommended because of potential winter injury problems. If manure is used, it should be broadcast at moderate rates and worked into the soil in late fall or early spring before planting.

No more than 7 t/ha of poultry manure (20 cubic m/liquid), 40 t/ha of cattle (100 m<sup>3</sup> liquid), 35 t/ha hog (65 m<sup>3</sup> liquid) should be applied. Since manure is extremely variable in nutrient content, make sure you analyze it for nutrient content before application. See page 21 for more details. When manure is used, reduce the rate of fertilizer. Table 3-5, page 21, shows the average composition of some manures and suggested reduction of fertilizer when manure is used.

## pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. To determine pH, take a soil

sample. For information on soil sampling, consult *Soil Testing*, page 15.

Always take a soil sample before establishing a new planting. If lime is required, incorporate it during soil preparation. In established orchards, a soil sample in the tree row is recommended every 3 years to be sure the pH is at a satisfactory level. If pH is low (acidic), lime can be applied to the sod cover in the fall, or before cultivation in the spring. The results will not be immediately evident because lime moves slowly into the soil.

The target pH before establishing a new orchard is 6.5 on sandy soils and 6.0 on clay soils. If the pH in established orchards is above 5.6, lime is not needed. In established orchards, when the pH on clay loam soils drops below 5.1, and on sandy soils below 5.6, apply lime. This will raise the soil pH (reduce the acidity), and also supply calcium. Use dolomitic lime (high in magnesium) on soils low in magnesium. Rates of application will vary with soil type and initial pH. The buffer pH indicates the rate of lime to apply. For information on lime, consult *Soil Acidity and Liming*, page 18.

## Leaf Analysis

In established plantings, leaf analysis is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the tree. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests consult *Plant Analysis*, page 17.

Nutrient uptake is affected by many orchard conditions. Consequently, each year the nutrient levels vary slightly depending upon the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the leaves and the relative amounts must be balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients, which will be reflected in the leaf analysis. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

**TABLE 7-1. Nutrient Level Range (% Dry Weight) of Mid-Shoot Leaves**  
(taken last 2 weeks of July from mature trees)

Leaf Analysis	Nitrogen* (N)		Potassium (K)		Magnesium (Mg)
	Low if below	High if above	Low if below	High if above	Low if below
APPLE					
Delicious, Crispin	2.2	2.7	1.4	2.2	0.25
Empire, Spy	2.1	2.6	1.3	2.1	0.25
McIntosh, others	2.0	2.5	1.2	2.0	0.25

\* Leaf nitrogen in non-bearing trees should be 0.2% higher  
Apple trees on M.9 or M.26 rootstocks should be 0.2% higher

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. Consult Table 7-1, *Nutrient Level Range of Mid-Shoot Leaves*, to find the optimum nutrient level ranges for apples.

Fertilizer requirements are adjusted to the system of soil management, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered in determining the fertilizer required.

## Fertilizer for Apples

### Fertilizer for Non-bearing Apples

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Nutrient levels in the topsoil considered adequate for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium, and 1000–5000 ppm calcium. Table 7-2, *Phosphorus and Potassium Soil Requirements Before Planting Apples*, provides information on fertilizer rates prior to planting.

During the early years, before new trees bear their first crop, an annual application in early spring of nitrogen and potash is usually required. For suggested rates, refer to sections which follow.

If the soil has been prepared properly, including deep cultivation and addition of organic matter, there should be an adequate supply of other nutrients to sustain the tree in the juvenile years. On coarse-textured, infertile soils, the use of a starter solution at planting time (e.g., 10–52–10

or 20–20–20) may give the trees a needed boost. High nitrogen levels can result in excessive growth and incomplete tree hardening. The use of cover crops to check late season growth in cultivated orchards is strongly recommended, especially in new plantings. Cover crops such as Italian rye grass, sown about July 1, take up much of the available nitrogen in the soil — checking tree growth.

On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can result if placed too close.

**TABLE 7-2. Phosphorus & Potassium Soil Requirements Before Planting Apples**

Soil Phosphorus	New Plantings of apples*	Soil Potassium	New plantings of apples*
Soil Test (ppm P)	Phosphate (P <sub>2</sub> O <sub>5</sub> ) req'd kg/ha	Soil Test (ppm K)	Potash (K <sub>2</sub> O) req'd kg/ha
0–3	80 L	0–15	180 L
4–5	60 L	16–30	170 L
6–7	50 L	31–45	160 L
8–9	40 M	46–60	140 L
10–12	20 M	61–80	110 L
13–15	0 H	81–100	70 M
16–20	0 H	101–120	40 M
21–25	0 VH	121–150	20 M
26–30	0 VH	151–180	0 H
31–40	0 VH	181–210	0 H
41–50	0 VH	211–250	0 VH
51–60	0 VH	250 +	0 E
61–80	0 E		
80 +	0 E		

\* For established apple trees, leaf analysis is used to estimate requirements of N, P + K

## Fertilizer for Bearing Apples

Most bearing orchards require annual applications of both nitrogen (N) and potassium (K) fertilizer. These 2 elements significantly affect growth and productivity.

Do not apply excessive amounts of nitrogen. Late or excessive applications may result in poor fruit colour and quality. Also, available nitrogen late in the season encourages the tree to grow instead of hardening off, increasing the possibility of winter injury.

Using cover crops in cultivated orchards helps to lower the nitrogen level in the latter part of the season. Cover crops such as Italian rye grass, sown about July 1, take up much of the available nitrogen in the soil, thus checking tree growth. In herbicide-treated strips under trees, weed growth late in the season takes up extra nitrogen, helping to harden off trees and improve fruit quality.

## Nitrogen (N)

Nitrogen is necessary for many tree functions including growth, fruit bud formation, fruit set and fruit size. Cultivars differ in their nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also influence application rates. If pruning is to be severe, cut nitrogen rates back or eliminate it for a year. Tree growth, foliage colour, fruit quality including colour and storability, nutrient balance in leaves and soil, are also important considerations. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Do not apply urea (46-0-0) to sod orchards since some of the nitrogen may be lost by volatilization. There are several forms of nitrogen available, but ammonium nitrate (34-0-0) or calcium ammonium nitrate (27-0-0) is the most economical form of nitrogen to use. If you are using blended fertilizers for your orchard, request ammonium nitrate as the N source.

## Nitrogen Rates

Given the variety of orchards systems, rootstocks, cultivars, and soil types, it is difficult to report the exact amount of nitrogen to apply. Research is under way to better evaluate the nitrogen needs of higher density supported planting systems. Until that research is completed be careful with nitrogen applications. Rely on leaf analysis to evaluate the nitrogen needs of your specific plantings. Table 7-3, *Approximate Grams of Actual Nitrogen Required Per Tree at Various Tree Density and Tree Ages, Growing in Sod* is an estimate of possible nitrogen requirements. When the tree

canopy has covered the space available, nitrogen fertilizer requirements will level out and will not increase indefinitely with tree age. Orchards grown under clean cultivation require about ½ the nitrogen required by orchards grown in sod. Again leaf analysis is the most reliable guide.

For all apple cultivars do not exceed the maximum rates of 200 kg actual N/ha per year, even in the case of a severe deficiency.

## Nitrogen Placement and Timing

Apply nitrogen fertilizer in early April. In cultivated orchards broadcast nitrogen under the tree canopy. In sod orchards place the nitrogen in a band under the drip line, or in the herbicide strip.

## Foliar Application of Nitrogen

Foliar applications of urea (46% nitrogen) have been used successfully on apples, when weather or crop conditions resulted in a need for additional nitrogen at a critical time. Late applications may adversely affect fruit quality. On apples, use no more than 2.7 kg N/1000 L water (6 kg urea) and apply at least 2000 L/ha starting 7-10 days after petal fall, and spacing the sprays about 10 days apart. Do not apply more than 3 times. Do not apply later than the end of July, or fruit quality and winter survival of the tree could be adversely affected.

Do not rely on urea sprays to completely substitute for soil applications if nitrogen is required.

## Phosphorus (P)

Phosphorus is not required in large amounts by apple trees. With few exceptions the level of phosphorus in Ontario soils is adequate at present without additional being required. Phosphorus does have a place for sod or cover crop maintenance. A soil test is the best way to determine if there is a need to apply this nutrient to the sod cover. In the absence of a soil test, a complete fertilizer (100 kg/ha 10-20-20) could be broadcast and incorporated before seeding a cover crop in an orchard. Phosphorus should also be applied before planting an orchard when it can be thoroughly incorporated in the soil if a soil test indicates a need. Phosphorus soil test values between 12-20 ppm are considered adequate for tree fruit establishment and production.

## Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance. An excess amount of potassium can lead to deficiency of magnesium (Mg), so take care when deciding upon potassium rates. Potassium soil test values between 120-150 ppm are considered

**TABLE 7-3. Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Density and Tree Ages, Growing in Sod\***

		TREE DENSITY										
hectare		600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
acre		240	320	400	480	560	640	720	800	880	960	1040
Y E A R	1	30	30	30	30	30	30	30	30	30	30	30
	2	60	60	60	60	60	60	60	60	60	60	60
	3	90	90	90								
	4	120	120	120								
	5	150	150	150								
	6	180	170	168								
	7	206	190	186								
	8	232	210	204								
	9	258	230									
	10	284	250									
	11	310										
	12	336										
	13											
	14											
	15											
	16											
	17											
	18											
	19											
	20											

Use leaf analysis to determine nitrogen needs.

Use leaf analysis to determine nitrogen needs.

Reduce nitrogen rate by 1/2 if orchard is cultivated without sod between tree rows.

Do not exceed 200 kg of actual nitrogen/hectare/year regardless of number of trees/hectare.

\* These are approximate values. The exact amount of nitrogen to apply is a function of soil nitrogen level, cultivar, rootstock, soil moisture, etc. The best way to determine nitrogen requirements is by taking leaf analysis regularly.

adequate when planting tree fruits. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, use approximate rates in Table 7-4, *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod*, to get started.

Apply no more than 3 kg of K<sub>2</sub>O (5 kg muriate of potash) per mature standard apple tree in a year, regardless of how severe the deficiency. When fertilizing trees of dwarfing rootstocks, consult Table 7-4, page 48, for approximate rates of muriate of potash to apply. When the tree canopy has covered the space available, potassium fertilizer requirements will level out and will not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.

#### Placement and Timing

In early spring, apply potassium separately or combined with nitrogen. Some orchardists make fall applications

because of time constraints in the spring. However, some potassium may be lost by leaching over winter. For this reason, apply in spring if possible. In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

#### Magnesium (Mg)

Magnesium deficiency is becoming more evident in orchards, particularly when high rates of potash are used. Magnesium deficiency can lead to premature drop of fruit at harvest, especially with McIntosh. Magnesium deficient trees have older leaves that are pale in colour, as magnesium is a part of the chlorophyll molecule. Leaf analysis is the best way to evaluate Mg needs.

Foliar sprays of magnesium are effective in correcting this deficiency for the current year only (see Table 7-5, *Magnesium Foliar Sprays*). For more permanent correction, soil applications of Mg are required. Magnesium soil test values between 100-250 ppm are considered adequate when planting tree fruits.



**TABLE 7-4. Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod\***

		TREE DENSITY											
hectare		< 500	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
acre		< 200	240	320	400	480	560	640	720	800	880	960	1040
Y E A R	1	80	80	80	80	80	80	80	80	80	80	80	80
	2	80	80	80	80	80	80	80	80	80	80	80	80
	3	80	80	80	80								
	4	80	80	80	80								
	5	80	80	80	80								
	6	80	80	80	80								
	7	80	70	63	52								
	8	80	70	63	52								
	9	80	70	63	52								
	10	80	70	63	52								

Use leaf analysis to determine potash needs.

Do not exceed 800 Kg of 0-0-60/ha/yr regardless of number of trees/hectare.

\* These are approximate values. The exact amount of muriate of potash to apply is a function of soil potassium level, cultivar, rootstock, soil moisture, etc. The best way to determine potash requirements is by leaf analysis.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate; therefore, apply magnesium sulfate separately or try it on a few trees first. Check manufacturer's label regarding mixing magnesium chelates<sup>1</sup> with pesticides.

For long-term corrections, soil applications of Mg can be made, but the response is not usually immediate. On some soil types, a single early spring application of soil applied Mg has not worked well. A second or third application the following spring may be required before the Mg level in the tree improves. To be sure that fruit drop is not a problem during this waiting period, apply foliar sprays for the first 2 years, in addition to soil applications.

For soil corrections on acidic soils, use dolomitic limestone to supply magnesium and raise the soil pH. Where lime is not required, apply 5-7 kg/mature standard tree, and 3-4 kg/mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer containing approximately 21% potash and 11% magnesium. This material is applied in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. No further potash (e.g. 0-0-60) is needed, but apply nitrogen at recommended rates. Other sources of Mg may also work well as a soil application. If Mg is being blended with the fertilizer, apply at least 80 kg of available Mg per hectare when the fertilizer is spread.

### Calcium (Ca)

Lack of calcium is associated with fruit problems in apple. In Ontario, bitter pit of apple is the most common problem associated with calcium.

1. Use chelates recommended for foliar sprays.

**TABLE 7-5. Magnesium Foliar Sprays**

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1000 L water	Wet tree to point of run-off. Do not concentrate beyond 40 kg/1000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

\* Use chelates recommended for foliar sprays.



Foliar applications of calcium (Ca) to apples reduces the incidence of bitter pit and cork spot. Where these disorders have been a problem in the past, 4 foliar sprays, applied 2 weeks apart, beginning in mid-July, works well. (Consult Table 7-6, *Calcium Foliar Sprays*, for more details.) Where a greater amount of total calcium is required, additional applications can be made by beginning earlier (mid-June) or by continuing until harvest.

Calcium has been shown to advance fruit maturity, and adjustments in harvest timing may be required as a result of calcium foliar sprays.

Some formulations of calcium chloride (CaCl<sub>2</sub>) have resulted in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective, therefore water volumes capable of wetting the entire tree are required. The more calcium that can be applied, the better the control — but there is a concentration at which calcium can cause foliar burning.

Do not concentrate CaCl<sub>2</sub> (77% flakes) beyond 5 kg/1000 L of water at the mid-July timing and no more than 7 kg/1000 L for the applications at or beyond mid-August. Do not apply Ca formulations containing nitrogen after the end of July, or fruit quality and storability may suffer.

For all the formulations, be sure to consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results, up to 12 kg/ha of actual Ca is often required in a total of 4, or more, sprays. Ca sprays may cause foliage and/or fruit injury if applied when low temperature and wet weather delay drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Recent studies with calcium sprays on McIntosh have failed to show an advantage in fruit firmness and keeping quality when fruit was stored in a regular controlled atmosphere storage for 5 1/2 months. Applications of Ca should be limited to fruit that has a known deficiency and/or is prone to bitterpit or cork spot. For more information on calcium disorders, consult OMAFRA Factsheet *Bitter Pit Control in Apples*, Order No. 00-009.

## Micronutrients for Apples

Deficiencies of micronutrients or trace elements are not widespread in Ontario apple plantings. Boron deficiency is perhaps the most common. Deficiencies of zinc, manganese, and iron may show up occasionally, particularly in alkaline soils.

The desirable range for micronutrients is quite narrow. More damage is possible with excesses than with deficiencies. For this reason, do not apply micronutrients to apples except when deficiency is confirmed by leaf analysis or visible symptoms.

Only the nutrient that is deficient should be applied in sufficient quantities to correct the problem.

### Boron (B)

Boron deficiency occurs mainly on alkaline soils or on sandy knolls. Apples are the most sensitive of the fruit crops to boron deficiency. Symptoms include internal breakdown of highly coloured fruit that drops prematurely. A boron concentration in apple leaf tissue in mid-July of less than 20 ppm is considered deficient.

Apply foliar sprays of soluble boron fertilizers such as "Solubor" at rates supplying 0.2 kg of available boron/1000 L water (1.0 kg Solubor/1000 L). Two applications 10–14 days apart starting in early June is usually adequate. When there is a boron deficiency, spray at least 2000 L/ha at each application. Other formulations of boron<sup>1</sup> are available. Consult manufacturer's label for rates and timing.

Boron excess may cause yellowing of leaf edges and midrib, reduced yields and a shortened storage life.

### Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions).

In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. Normally, this is not serious. Leaf manganese concentrations below 20 ppm in mid-July are considered deficient. Fruit size, yield, and quality appear to be unaffected. If the condition is severe, spray manganese sulfate at the rate of 1.3 kg of available Mn/1000 L water (5 kg manganese sulfate) at 2000 L/ha. Manganese chelates<sup>1</sup> are also effective in

1. Use chelates recommended for foliar sprays.

TABLE 7-6. Calcium Foliar Sprays

Timing	Product	Rate	Notes
4 sprays spaced 2 weeks apart beginning in mid-July. Additional sprays can be applied up to harvest.	Calcium Chloride* (77% flakes)	5 kg/1000 L water	NOT recommended on McIntosh or Idared  Wet tree to point of run-off. Pesticides may not be compatible — check label
	Calcium Nitrate	9 kg/1000 L water	Use only if leaf nitrogen is low. Do not apply later than the end of July. For pesticide compatibility consult labels.
	Other formulations including chelates	Consult label	

\* When using calcium chloride, mix the required calcium in a pail of water first, to be sure that all the product is dissolved before adding the slurry to the spray tank.

correcting manganese deficiency. Consult manufacturer's label for complete information on rates and timing.

On Red Delicious apples manganese toxicity can occur on coarse-textured soils when the soil is very acid (pH below 5.0). The symptoms known as "measles" are raised pimples on the bark underlain by dark brown spots. Other visual symptoms are leaf chlorosis, tip dieback, early leaf abscission, reduced flower bud development and shoot growth. Correction is sometimes possible by addition of lime to raise the soil pH. If possible, it should be worked into the soil. Soil sampling and addition of lime if pH is low is recommended prior to planting.

### Iron (Fe)

Iron deficiency, commonly termed "lime-induced chlorosis," is not widespread in Ontario orchards. Occasionally, 1 or 2 trees in an orchard may exhibit iron-deficiency symptoms. Often these trees are located near the site of previous lime or building plaster storage, etc., where the soil pH is abnormally high.

Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the tree is affected. Iron chelates<sup>1</sup> have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

### Zinc (Zn)

Zinc deficiency has been identified in some apple orchards in eastern Ontario. The symptoms of this deficiency are short internodes, small narrow leaves, interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes", giving rise to the typical "rosette" and "little leaf" description for zinc deficiency. Except in severe cases, only a few shoots on an otherwise normal tree will show symptoms. Leaf Zn levels below 15 ppm indicate a deficiency.

Zinc sulfate supplying 3.6 kg of Zn/1000 L water as a dormant spray in early spring is effective.

Dilute sprays in June of zinc sulfate or chelate<sup>1</sup> containing 0.35 kg Zn/ha (1 kg 36% ZnSO<sub>4</sub> or 5 L 6.5% Zn chelate<sup>1</sup>) are effective in correcting zinc deficiency on fruit trees. A fungicide for disease control that contains available zinc can be an asset in orchards that are continually low in zinc. Consult manufacturer's label for available zinc concentrations in the formulation.

**Warning: Do Not Concentrate Nutrient Sprays. Do not spray at temperatures above 25°C. Fruit injury is possible under these conditions.**

<sup>1</sup> Use chelates recommended for foliar sprays

# Apple Calendar

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
<b>Dormant</b>			
San Jose scale European fruit scale Lecanium scale	Superior Oil (60–70 vis)	60 L	Apply full rate of oil in 2000–3000 L of water/ha. 3000 L will give best results. On large standard trees, use 90 L of oil in 4500 L of water/ha. Do not apply full rate of oil more than once per season.
Oil may cause bark injury on Red Delicious, Empire and Mutsu (Crispin)			
<b>Green Tip up to Half-Inch Green</b>			
Scab protectants	<ul style="list-style-type: none"><li>• Polyram 80 DF</li><li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li><li>• Dikar WP</li><li>• Manzate 200 DF or Dithane DG or Penncozeb 75 DF</li><li>• <sup>4</sup>Vangard 75 WG</li></ul>	<ul style="list-style-type: none"><li>6.00 kg</li><li>6.00 kg</li><li>3.75 kg</li><li>4.00 kg</li><li>6.00 kg</li><li>6.00 kg</li><li>6.00 kg</li><li>6.00 kg</li><li>370 g</li></ul>	<p>Apply fungicide before spore release and keep growing leaves coated. It is generally advisable to alternate materials in a spray program. Read scab information on pages 59–63. When used in a full season program, Dikar at 6 kg/ha will suppress orchard mites. Higher water volumes aid in mite suppression. Consult label.</p> <p>Use Vangard as a protectant-type fungicide. Make no more than 2 applications per season, prebloom only. Vangard does not control other foliar or fruit diseases.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p>
<b>Half-Inch Green to Tight Cluster</b>			
European red mite Rosy apple aphid	<ul style="list-style-type: none"><li>• Superior oil (60–70 vis.)</li></ul>	60 L	Do not apply full rate of oil more than once/season. Apply full rate of oil in 2000–3000 L of water/ha. 3000 L will give best results. Test the stability of the emulsion by shaking in a jar. On large standard trees, use 90 L of oil in 4500 L of water/ha. Apply Superior oil for the control of European red mite before over-wintering eggs hatch. Usually the best timing is between <b>Half-Inch Green and Tight Cluster</b> when temperatures are getting warmer.
Rosy apple aphid	Pirimor 50 DF	1.7 kg	
Scab	Use one of the fungicides listed at Green Tip or use: <ul style="list-style-type: none"><li>• Nova 40 W plus</li><li>• Dithane DG</li><li>• Nova 40 W plus</li><li>• Polyram 80 DF</li><li>• Nova 40 W plus</li><li>• Maestro 75 DF</li><li>• <sup>2</sup>Nustar 20 DF plus</li><li>• Manzate 200 DF</li><li>• <sup>2</sup>Nustar 20 DF plus</li><li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li></ul> With Superior oil use one of: <ul style="list-style-type: none"><li>• Polyram 80 DF</li><li>• Dithane DG</li><li>• Manzate 200 DF</li></ul>	<ul style="list-style-type: none"><li>340 g</li><li>3.00 kg</li><li>340 g</li><li>3.00 kg</li><li>340 g</li><li>3.00 kg</li><li>100 g</li><li>3.00 kg</li><li>100 g</li><li>3.00 kg</li><li>1.875 kg</li><li>2.00 kg</li><li></li><li>6.00 kg</li><li>6.00 kg</li><li>6.00 kg</li></ul>	<p>See <i>Use of Sterol-Inhibiting Fungicides</i> (Nova, Nustar), at end of apple calendar, page 62.</p> <p>Do not apply Nustar within 77 days of harvest.</p> <p><sup>2</sup>Minimum period for reentry is 12 hrs. See product label for specific reentry requirements and precautions.</p> <p>Add fungicide to tank when 1/4 to 1/2 full of water and mix thoroughly. Add superior oil last when tank is at least 3/4 full of water.</p>

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Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
Use of Nova 40 W or Nustar 20 DF	Apply Nova or Nustar plus a protectant fungicide (e.g., Captan 80 WP) within 72–96 hrs following the beginning of the first scab infection period recorded near tight cluster. Follow up sprays of Nova or Nustar plus a protectant fungicide should be applied consecutively at 7–10 day intervals. Do not stretch consecutive applications past 10 days. Apply at least 2, but no more than 4, sprays per season, preferably between <b>Tight Cluster</b> and <b>First Summer Spray</b> . Follow up with a protectant fungicide program, as required, after the last Nova or Nustar application. After the last Nova or Nustar plus a protectant fungicide application, apply a protectant fungicide before the next scab infection period, but not within 5 days of the Nova or Nustar plus protectant fungicide application.		
Post Infection program	Apply Nova or Nustar plus a protectant fungicide as soon as possible (within 96 hrs.) after the start of an infection period. Follow up with a second application 7–10 days later. (See <i>Use of Sterol Inhibiting Fungicides</i> at end of apple calendar, page 62.)		
Powdery mildew	<ul style="list-style-type: none"> <li>Nova 40 W</li> <li>Nustar 20 DF</li> <li>Dikar WP</li> <li>Senator 70 WP plus Captan 50 WP</li> <li>Benlate 50 WP plus Polyram 80 DF</li> <li>Benlate 50 WP plus Captan 50 WP</li> <li>Benlate 50 WP plus Manzate 200 DF</li> <li>Sulphur 92</li> </ul>	340 g 200 g 7.50 kg 625 g 3.25 kg (6.0) 550 g 3.25 kg (6.0) 550 g 3.25 kg (6.0) 550 g 3.25 kg (6.0) 10.0 kg	Begin application at tight cluster and continue to <b>First Summer Spray</b> if powdery mildew was prevalent the previous year; apply Nova 40W or Nustar 20 DF beginning at <b>Green Tip</b> . Additional sprays beyond <b>First Summer Spray</b> may be needed on susceptible varieties or if disease pressure is severe. Do not apply more than 4 Nova 40W or Nustar 20 DF applications per season. Do not apply Nustar within 77 days to harvest. Where mildew is a problem on varieties such as Idared, Cortland and Tolman Sweet, spray at weekly intervals from bud burst until the terminal buds are formed. For scab control with sulphur, add 1 of the scab protectant fungicides. For scab control with mixtures, use the higher rate in brackets. Do not use sulphur on Delicious. <i>Minimum period for reentry is 12 hrs. See product label for specific reentry requirements and precautions.</i>
<b>Tight Cluster to Pink</b>			
Tentiform leaf miner	<ul style="list-style-type: none"> <li>Pounce 384 EC</li> <li>Decis 5 EC</li> <li>Ripcord 400 EC or Cymbush 250 EC</li> <li>Matador 120 EC</li> <li>Confirm 240 F</li> </ul>	520 mL 250 mL 250 mL 400 mL 83 mL 1.00 L	*Pyrethroid applications require thorough spray coverage on trunk and scaffold limbs. Consult agriphone for timing. Pyrethroids will also control spring feeding caterpillars and tarnished plant bugs. Do not apply a pyrethroid more than once per season. Apply Confirm at first egg hatch. Confirm will suppress leafminer populations. Continued monitoring after application is recommended. Do not apply more than twice per season. <i>Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.</i>
Scab	Use one of the fungicides listed at <b>Half-Inch Green To Tight Cluster</b> , page 51. See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
Cedar apple rust Quince rust	<ul style="list-style-type: none"> <li>Ferbam 76 WDG</li> <li>Dikar WP</li> <li>Polyram DF</li> <li>Dithane DG or Penncozeb 75 DF</li> <li>Nova 40W plus Dithane DG</li> </ul>	2.50 kg 6.00 kg 6.00 kg 6.00 kg 6.00 kg 340 g 3.00 kg	Include in each spray up to and including <b>First Summer Spray</b> . When used for a scab control program Nova 40W will control rust diseases. For specifically controlling rust diseases, begin applications of Nova 40W plus Dithane DG at tight cluster and continue at 7–10 day intervals to <b>First Summer Spray</b> . Do not exceed 4 applications of Nova 40 W per season.
Plant bugs	<ul style="list-style-type: none"> <li>Cygon 480 E</li> </ul>	2.50 L	Where troublesome, add to one spray before bloom. Will also control Spring-feeding caterpillars and Green fruitworm.
Spring-feeding caterpillars Green fruitworm	<ul style="list-style-type: none"> <li>Guthion 50 WP or APM 50 W or Sniper 50 W</li> <li>Zolone Flo</li> <li>Imidan 50 WP</li> </ul>	2.10 kg 2.10 kg 2.30 kg 2.00 kg 3.75 kg	This spray is not necessary if a synthetic pyrethroid was applied for tentiform leafminer. Make no more than 3 applications of Zolone Flo per season. <i>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</i>
<b>Full Pink</b>			
Scab	Use 1 of the fungicides listed at <b>Half-Inch Green To Tight Cluster</b> . See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
European red mite	<ul style="list-style-type: none"> <li>Carzol 92 SP</li> </ul>	1.10 kg	Miticides are most effective when used alone. Carzol is harsh on beneficial mite species and bees. Application before <b>Petal Fall</b> is preferred.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
			

Powdery mildew	• Nova 40 W	340 g	<p>Begin application at tight cluster and continue to <b>First Summer Spray</b>. If powdery mildew was prevalent the previous year, apply Nova 40W or Nustar 20 DF beginning at <b>Green Tip</b>. Additional sprays beyond <b>First Summer Spray</b> may be needed on susceptible varieties or if disease pressure is severe. Do not apply more than 4 Nova 40W or Nustar 20 DF applications per season. Do not apply Nustar within 77 days to harvest. Where mildew is a problem on varieties such as Idared, Cortland and Tolman Sweet, spray at weekly intervals from bud burst until the terminal buds are formed.</p> <p>For scab control with sulphur, add 1 of the scab protectant fungicides. For scab control with mixtures, use the higher rate in brackets.</p> <p>Do not use sulphur on Delicious.</p>
	• <sup>2</sup> Nustar 20 DF	200 g	
	• Dikar WP	7.50 kg	
	• Senator 70 WP plus	625 g	
	• Captan 50 WP	3.25 kg (6.0)	
	• Benlate 50 WP plus	550 g	
	• Polyram 80 DF	3.25 kg (6.0)	
	• Benlate 50 WP plus	550 g	
	• Captan 50 WP	3.25 kg (6.0)	
	• Benlate 50 WP plus	550 g	
	• Manzate 200 DF	3.25 kg (6.0)	
	• Sulphur 92	10.0 kg	

<sup>2</sup> Minimum period for reentry is 12 hrs. See product label for specific reentry requirements and precautions.

### Tight Cluster to Pink

Tentiform leaf miner	• *Pounce 384 EC	520 mL	<p>*Pyrethroid applications require thorough spray coverage on trunk and scaffold limbs. Consult agriphone for timing. Pyrethroids will also control spring feeding caterpillars and tarnished plant bugs. Do not apply a pyrethroid more than once per season.</p> <p>Apply Confirm at first egg hatch. Confirm will suppress leafminer populations. Continued monitoring after application is recommended. Do not apply more than twice per season.</p>
	• *Decis 5 EC	250 mL	
	• *Ripcord 400 EC	250 mL	
	or *Cymbush 250 EC	400 mL	
	• *Matador 120 EC	83 mL	
	• Confirm 240 F	1.00 L	

<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.

Scab	Use one of the fungicides listed at <b>Half-Inch Green To Tight Cluster</b> , page 51. See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
Cedar apple rust	• Ferbam 76 WDG	2.50 kg	<p>Include in each spray up to and including <b>First Summer Spray</b>.</p> <p>When used for a scab control program Nova 40W will control rust diseases. For specifically controlling rust diseases, begin applications of Nova 40W plus Dithane DG at tight cluster and continue at 7–10 day intervals to <b>First Summer Spray</b>.</p> <p>Do not exceed 4 applications of Nova 40 W per season.</p>
Quince rust	• Dikar WP	6.00 kg	
	• Polyram DF	6.00 kg	
	• Dithane DG	6.00 kg	
	or Penncozeb 75 DF	6.00 kg	
	• Nova 40W plus	340 g	
	• Dithane DG	3.00 kg	
Plant bugs	• Cygon 480 E	2.50 L	Where troublesome, add to one spray before bloom. Will also control Spring-feeding caterpillars and Green fruitworm.
Spring-feeding caterpillars	• <sup>4</sup> Guthion 50 WP	2.10 kg	<p>This spray is not necessary if a synthetic pyrethroid was applied for tentiform leafminer.</p> <p>Make no more than 3 applications of Zolone Flo per season.</p>
Green fruitworm	or <sup>4</sup> APM 50 W	2.10 kg	
	or <sup>4</sup> Sniper 50 W	2.30 kg	
	• Zolone Flo	2.00 kg	
	• Imidan 50 WP	3.75 kg	

<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.

### Full Pink

Scab	Use 1 of the fungicides listed at <b>Half-Inch Green To Tight Cluster</b> . See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
European red mite	• Carzol 92 SP	1.10 kg	Miticides are most effective when used alone. Carzol is harsh on beneficial mite species and bees. Application before <b>Petal Fall</b> is preferred.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
Resistance to miticides is increasing in Ontario orchards. See <i>Pest Resistance</i> , pages 26–28			
Rosy apple aphid	• <sup>3</sup> Pirimor 50 DF	1.70 kg	Preferred time for control. See note on <i>Bee Poisoning</i> , page 41. Make no more than 3 applications of Zolone Flo per season. Cygon may cause russetting. <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• Zolone Flo	2.00 L	
	• Cygon 480 EC	3.75 L	

The obliquebanded leafroller is resistant to organophosphate and pyrethroid insecticides in some parts of the province. Use one of the indicated materials as recommended where this resistance is present. Frequent monitoring of leafroller life stages is recommended to accurately time sprays. Dipel, Foray and Confirm are most effective on early instars. Alternate materials between generations. For example, if Confirm was used for the overwintering generation, use Dipel or Foray for the first summer generation. Or, if Confirm was used for the summer generation, use Dipel or Foray the following spring.

Obliquebanded leafroller	• Confirm 240 F	1.00 L	Make no more than 2 applications of Confirm per year
	• Dipel WP or	2.25 kg	Two applications of Dipel or Foray at 5–7 day intervals may be required to cover extended activity of the larvae. For best results when using Dipel or Foray, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. When applied for leafroller control, these products will also control other caterpillars.
	Foray 48 BA	2.80 L	

### Bloom Period

Do not apply insecticides while apple trees are in bloom.  
See *Bee Poisoning*, page 41.

Scab	Use one of the fungicides listed at <b>Half-Inch Green To Tight Cluster</b> . See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
Fire blight	Streptomycin 17	600 g/1000 L	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Because Streptomycin 17 is UV light sensitive it is only effective for 2–3 days. Re-application is needed after 2–3 days if warm, wet conditions (above 20°C) prevail. 2–4 sprays during bloom may be required for fire blight control. To avoid resistance use a maximum of 4 sprays per season, see <i>Fire Blight of Apple</i> , page 63 for details.

### Petal Fall (CALYX) When most petals have fallen

Scab	Use one of the fungicides recommended at <b>Half-Inch Green To Tight Cluster</b> . See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
Tentiform leafminer	• <sup>3</sup> Admire 240 F	380 mL	In years where leafminer egg hatch is delayed, a pyrethroid can be applied at petal fall when first sapfeeding mine on underside of cluster leaves is detected. This treatment will also control mullein bug, tarnished plant bug and spring feeding caterpillars. Do not apply pyrethroids more than once per season.  When leafminer egg hatch is well underway apply Lannate when first tissue feeding mine is detected on the upper surface of the cluster leaves. Do not apply Lannate to Early McIntosh or Wealthy varieties.  Apply Admire when sap feeders are present. Will also control green apple aphid, rosy apple aphid, mullein bug and white apple leafhopper at this timing. No more than 2 applications per season.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• <sup>*</sup> Pounce 384 EC	520 mL	
	• <sup>*</sup> Decis 5 EC	250 mL	
	• <sup>*</sup> Ripcord 400 EC	250 mL	
	or <sup>*</sup> Cymbush 250 EC	400 mL	
	• <sup>**</sup> Matador 120 EC	83 mL	
	• <sup>3</sup> Lannate T–N–G	1.60 kg	
Rosy apple aphid	• <sup>3</sup> Admire 240 F	230 mL	Admire applied at this time will also control green apple aphid, white apple leafhopper and tentiform leafminer. Make no more than 2 applications of Admire per season.  Cygon may cause russetting. Cygon also controls oystershell scale.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• <sup>3</sup> Pirimor 50 DF	1.70 kg	
	• Zolone Flo	2.00 L	
	• Cygon 480 E	3.75 L	
Mullein leaf bug	• <sup>3</sup> Admire 240 F	380 mL	Timing is critical. Admire applied at this time will also control green apple aphid, rosy apple aphid, white apple leafhopper, and tentiform leafminer. Make no more than 2 applications of Admire per season.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• Diazinon 50 WP	3.25 kg	
	• <sup>3</sup> Lannate T–N–G	1.60 kg	
	• Decis 5 EC	200 mL	

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
Oystershell scale	• <sup>4</sup> Guthion 50 WP or <sup>4</sup> Sniper 50 W	2.10 kg 2.30 kg	Apply as soon as petals are off. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Plum curculio Caterpillars	• <sup>4</sup> Guthion 50 WP or <sup>4</sup> APM 50 W or <sup>4</sup> Sniper 50 W • Imidan 50 WP • Zolone Flo	2.10 kg 2.10 kg 2.30 kg 3.75 kg 3.00 mL	<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
European apple sawfly	• <sup>4</sup> Guthion 50 WP or <sup>4</sup> Sniper 50 W	2.25 kg 2.30 kg	Apply as a special spray to orchards where there has been a history of damage. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
European red mite	• Apollo SC • Carzol 92 SP	300 mL 1.10 kg	Apollo kills mite eggs. Apply when mites are mostly in the egg stage, and before there are more than 3 active mites per leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1100 L of water/ha. Make no more than 1 application/yr. Carzol is harsh on beneficial mite species and bees.
Blister spot	• <sup>2</sup> Aliette WDG	2.50 kg	Begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not exceed 3 applications. Do not mix with copper compounds. <sup>2</sup> Minimum period for reentry is 12 hrs. See product label for specific reentry requirements and precautions.
The obliquebanded leafroller is resistant to organophosphate and pyrethroid insecticides in some parts of the province. Use one of the indicated materials as recommended where this resistance is present. Frequent monitoring of leafroller life stages is recommended to accurately time sprays. Dipel, Foray and Confirm are most effective on early instars. Alternate materials between generations. For example, if Confirm was used for the overwintering generation, use Dipel or Foray for the first summer generation. Or, if Confirm was used for the summer generation, use Dipel or Foray the following spring.			
Obliquebanded leafroller	• Confirm 240 F • Dipel WP or Foray 48 BA	1.00 L 2.25 kg 2.80 L	Do not apply Confirm more than 2 times per season. Two to 3 applications of Dipel or Foray at 5–7 day intervals may be required to cover extended activity of the larvae. For best results when using Dipel or Foray, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.
	• <sup>3</sup> Lannate T–N–G	1.60 kg	Lannate is most effective on 4 <sup>th</sup> and 5 <sup>th</sup> instar larvae. Do not use Lannate more than once per season. When applied for leafroller control, these products will also control other caterpillars. <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Powdery mildew	Use one of the fungicides listed at <b>Half-Inch Green To Tight Cluster</b> .		
<b>First Summer Spray (7 to 10 days after CALYX)</b>			
Scab	Use one of the fungicides recommended at <b>Green Tip</b> or use Nova 40W or Nustar 20 DF plus a protectant fungicide (see <b>Half-Inch Green to Tight Cluster</b> ). An extra scab spray may be required between <b>Calyx</b> and <b>First Summer Spray</b> . See page 63 for <i>Control Under Adverse Weather Conditions</i> .		
Plum curculio	Use one of the insecticides listed under <b>Petal Fall (Calyx)</b> .		
Fire blight	• Streptomycin 17	600 g/1000 L	To control shoot blight especially if blossom blight has occurred.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
European red mite Two-spotted spider mite	• Apollo SC • <sup>3</sup> Agri-Mek 1.9 EC	300 mL 750 mL	<p>Apply Apollo no later than 14 days after petal fall. Apollo kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites/leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1100 L of water /ha. Make no more than 1 application of Apollo/yr.</p> <p>Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L superior oil and a minimum of 1000 L of water /ha. Agri-Mek should be applied when the majority of mites are in the nymph stage. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned varieties. <b>Do not use within 14 days of a Captan application. Do not apply more than once per season.</b> Ideally, alternate yearly with other early season miticides (e.g., Superior oil, Apollo).</p> <p>Miticides are best applied alone. Resistance to miticides is increasing in Ontario orchards. See <i>Pest Resistance to Insecticides, Fungicides and Miticides</i>, page 26.</p> <p><sup>3</sup>Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.</p>
Rosy apple aphid	• <sup>3</sup> Admire 240 F • <sup>3</sup> Pirimor 50 DF • Zolone Flo • Cygon 480 E	230 mL 1.70 kg 2.00 L 3.75 L	<p>Admire applied at this time will also control green apple aphid and white apple leafhopper. Make no more than 2 applications of Admire/season. Cygon may cause russetting. Cygon also controls oystershell scale.</p> <p><sup>3</sup>Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.</p>
Powdery mildew	Use one of the fungicides listed under <b>Half-Inch Green to Tight Cluster</b> .		
Blister spot	Copper 53W	3.00 kg	To reduce the incidence of blister spot lesions on Crispin (Mutsu) and other sensitive varieties, apply up to 3 applications of Copper 53W beginning 10 days after petal fall. Use hydrated lime as a safener (to reduce the risk of phytotoxicity) at a rate of 6 kg per 1 kg of Copper 53W per 1000 L of water. Apply 3000 L of water/ha.

### Subsequent Summer Sprays

Scab	<p>Until the end of the primary scab season use one of the fungicides recommended at <b>Half-Inch Green to Tight Cluster</b>. For summer (secondary) scab infections, use one of the following:</p>		
	<ul style="list-style-type: none"> <li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>• Dikar WP</li> <li>• Polyram 80 DF</li> <li>• Manzate 200 DF or Dithane DG or Penncozeb 75 DF</li> </ul>	6.00 (3.0) kg 3.75 (2.0) kg 4.00 (2.0) kg 6.00 (5.0) kg 6.00 (4.5) kg 6.00 (4.5) kg 6.00 (4.5) kg	<p>If scab is controlled in your orchard use the lower rate given in brackets. If secondary lesions develop, see page 63, <i>Deactivation of Established Scab Lesions</i>. Do not apply Polyram, Dikar, Manzate, Dithane or Penncozeb within 45 days of harvest.</p>
Sooty blotch /fly speck	<ul style="list-style-type: none"> <li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>• Benlate 50 WP plus Captan 50 WP</li> <li>• Zineb 80 W</li> </ul>	6.00 kg 3.75 kg 4.00 kg 550 g 3.25 kg 4.25 kg	<p>Repeat application of Captan in 2 weeks</p> <p>Both Captan and Benlate will control Bull's Eye Rot. All materials provide some protection against other storage rots.</p>
Codling moth	<ul style="list-style-type: none"> <li>• Imidan 50 WP</li> <li>• <sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li> <li>• Zolone Flo</li> <li>• Sevin XLR Plus</li> <li>• Confirm 240 F</li> </ul>	3.75 kg 2.10 kg 2.10 kg 2.30 kg 2.00 kg 2.30 L 1.00 L	<p>Use pheromone traps to time sprays. See Pub. 310, <i>Integrated Pest Management for Ontario Apple Orchards</i> for information on how to monitor for this pest. Guthion and APM will control scale crawlers. Zolone also controls aphids.</p> <p>Apply Confirm at first egg hatch. Confirm may also suppress leaf-feeding caterpillars. Do not apply more than twice/season. Confirm <b>does not</b> control apple maggot.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p>



Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
Apple maggot	<ul style="list-style-type: none"> <li>• Imidan 50 WP</li> <li>• <sup>4</sup>Guthion 50 WP</li> <li>or <sup>4</sup>APM 50 W</li> <li>or <sup>4</sup>Sniper 50 W</li> <li>• Zolone Flo</li> <li>• Cygon 480 E</li> <li>• Sevin XLR plus</li> <li>• Diazinon 50 W</li> </ul>	3.75 kg 2.10 kg 2.10 kg 2.30 kg 3.00 L 4.25 L 2.30 L 3.25 kg	Base initial spray on visual trapping (see Pub. 310, <i>Integrated Pest Management for Ontario Apple Orchards</i> ). Subsequent applications should be made at 14–21 day intervals or as required based on monitoring.  Cygon may not give sufficient apple maggot control for fresh market apples and may cause russetting on some varieties.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>Special Sprays</b>			
Blister spot	<ul style="list-style-type: none"> <li>• Copper 53 W</li> </ul>	3.00 kg	See comments on blister spot control under <b>First Summer Spray</b>
Green apple aphid	<ul style="list-style-type: none"> <li>• <sup>3</sup>Admire 240 F</li> </ul>	230 mL	Make no more than 2 applications of Admire per season. Diazinon, Cygon and Zolone will also control codling moth. Pirimor, Admire, Thiodan and Endosulfan will also control white apple leafhopper.  Zolone will also control woolly apple aphid.  Cygon may cause russetting.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Rosy apple aphid	<ul style="list-style-type: none"> <li>• <sup>3</sup>Pirimor 50 DF</li> <li>• Zolone Flo</li> <li>• Cygon 480 E</li> <li>• Thiodan 50 WP</li> <li>or Endosulfan 50 W</li> <li>• Diazinon 50 W</li> </ul>	1.70 kg 2.00 L 3.75 L 4.50 kg 3.25 kg	
Woolly apple aphid	<ul style="list-style-type: none"> <li>• <sup>3</sup>Pirimor 50 DF</li> <li>• Malathion 25 W</li> <li>• Zolone Flo</li> </ul>	1.70 kg 6.75 kg 2.00 L	
White apple leafhopper	<ul style="list-style-type: none"> <li>• <sup>3</sup>Admire 240 F</li> <li>• Pirimor 50 DF</li> <li>• Carzol 92 SP</li> <li>• Sevin XLR Plus</li> <li>• Endosulfan 50 W</li> </ul>	200 mL 1.70 kg 1.10 kg 1.20 L 2.60 kg	
Potato leafhopper	<ul style="list-style-type: none"> <li>• Endosulfan 50 W</li> </ul>	2.60 kg	
Tentiform leafminer	<ul style="list-style-type: none"> <li>• <sup>1</sup>Lannate T–N–G</li> <li>• <sup>1</sup>Pounce 384EC</li> <li>• <sup>1</sup>Decis 5EC</li> <li>• <sup>1</sup>Ripcord 400 EC</li> <li>or <sup>1</sup>Cymbush 250 EC</li> <li>• <sup>3</sup>Matador 120 EC</li> </ul>	1.60 kg 520 mL 250 mL 250 mL 400 mL 83 mL	Apply Lannate when new sapfeeder mines show on the lower leaf surface and the first tissue feeder is seen. Do not apply Lannate to Early McIntosh or Wealthy.  <sup>1</sup> Use of synthetic pyrethroids for summer generations of tentiform leafminer is discouraged. Pyrethroids will not give effective control of larvae within the mines.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Dogwood borer Apple bark borer	<ul style="list-style-type: none"> <li>• Pounce 384 EC plus Superior Oil</li> </ul>	22 mL/100 L water with 2L Oil	Soak the trunk. Make 2 applications at 2–3 week intervals when adults are flying (late June to early August).
Obliquebanded leafroller	<ul style="list-style-type: none"> <li>• Dipel WP or Foray 48BA</li> <li>• Confirm 240 F</li> </ul>	2.25 kg 2.80 L  1.00 L	Two to 3 applications of Dipel or Foray at 5–7 days intervals may be required to cover extended activity of the larvae. For best results when using Dipel or Foray, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.  Apply a second spray of Confirm 10–14 days after the first application. Do not apply Confirm more than 2 times per season. When applied for leafroller control, these products will also control other leaf-feeding caterpillars.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m High	Comments
European red mite Two-spotted spider mite Rust mite	<ul style="list-style-type: none"><li>• <sup>3</sup>Pyramite 75 WP</li><li>• Kelthane 50 W</li><li>• Carzol 92 SP</li></ul>	300 gm 3.25 kg 1.10 kg	<p>Pyramite is most effective when applied to immature stages (but not eggs). Use established spray thresholds to time application. A higher rate of 600 gm/ha may be necessary if outbreaks of two-spotted mites occur. Miticides are best used alone. Apply any one miticide only once per season to delay the development of resistance. Use a minimum of 1000 L/ha of water when applying summer miticides. Carzol is harsh on beneficial mite species.</p> <p><b>Resistance to miticides is increasing in Ontario orchards. See <i>Pest Resistance to Insecticides, Fungicides and Miticides</i>, page 26.</b></p> <p><sup>3</sup>Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.</p>
Pinpoint and storage scab	Use one of the fungicides recommended for secondary scab in <b>Subsequent Summer Sprays</b> . Do not use fungicides closer than the stated interval to harvest (See Table 13-3, page 214).		
<b>Post Harvest Treatment</b>			
Blue mould Grey mould	<ul style="list-style-type: none"><li>• Mertect 45 F</li></ul>	0.5 L/500 L	For use in dip tank or drencher. Continuous agitation required. Follow label instructions. <b>DOES NOT CONTROL any blue mould (<i>Penicillium</i>) or grey mould (<i>Botrytis</i>) which is resistant to benzimidazole fungicides. (e.g., Benlate).</b>

# Guidelines for Protecting Young Non-Bearing Apple Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended to be used for protection of bearing orchards. Other protective measures include removal of neglected fruit trees in the area, careful selection of intercrops (where used) and a clean, weed-free environment. Rates are for dilute spraying. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Materials	Amount per 1000 L	Comments
<b>Early Spring</b>			
Phytophthora collar rot			See page 64.
<b>First Spray</b>			
Scab	• Dikar WP	2.00 kg	When green tissue shows. Repeat at 7–10 day intervals if wet weather occurs until late June.
Powdery mildew			
Cedar apple rust			
<b>Prebloom</b>			
Tentiform leafminer	• Synthetic pyrethroid		See section for bearing apples, Tentiform leafminer, page 52. Consult label for rates.
Leaf feeding insects	• Imidan 50 WP	1.25 kg	Before blossoms open in adjacent bearing orchards. Apply when caterpillars are small. Include with a fungicide spray. Not necessary if synthetic pyrethroid was used for tentiform leafminer.
<b>Bloom</b>			
Fire blight	• Streptomycin 17	600 g	Avoid over-stimulating growth. See <i>Fire Blight of Apple</i> , page 63.
<b>Summer Sprays</b>			
Leaf feeding insects	• Imidan 50 WP	1.25 kg	This spray will also control potato leathopper.
Aphids	• <sup>3</sup> Admire	75 mL	Spray if insects become abundant at any time.
	• <sup>3</sup> Pirimor 50 DF	500 g	
	• Cygon 480 E	1.25 L	<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• MetasystoxR 240 SC	1.50 L	
White apple leathopper	• <sup>3</sup> Admire	65 mL	
	• <sup>3</sup> Pirimor 50 DF	500 g	<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• Endosulfan 50 W	2.6 kg/ha	
Potato leathopper	• Endosulfan 50 W	2.6 kg/ha	
Diseases and Insects	Materials	Amount per 1000 L	Comments
Tentiform leafminer	• <sup>3</sup> Admire	125 mL	Vydate is very toxic to applicator. Timing is critical. If mines are visible on underleaf surface, consult crop advisor.
	• <sup>3</sup> Vydate L	3.0 L	<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Mites	• <sup>3</sup> Pyramite 75 WP	100 g	Check foliage frequently for mite injury. Spray if more than 7–10 mites/leaf are observed or at first sign of leaf bronzing.
			<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirement precautions.
Buffalo treehopper			Follow clean cultivation practices or remove legumes from cover crop.
Phytophthora collar rot	See page 64.		
Root lesion nematode	See page 30 for <i>Postplanting Treatment for Nematodes on Non-Bearing apples</i> .		

# Disease Control

## Managing Apple Scab

Apple scab, *Venturia inaequalis*, is the most serious fungal disease of apple in Ontario. The fungus attacks foliage, blossoms and fruits by defoliating trees and rendering fruit unmarketable. In addition to cultivated apple, apple scab also attacks flowering crabapples, mountain ash and fire-thorn.

### Primary Infection Periods

Once apple trees break dormancy and there is green tissue present, a primary infection can occur if the following 3 conditions are met: presence of mature ascospores, available moisture and resulting ascospore discharge.

#### 1. Presence of mature ascospores

There are always mature ascospores at bud break. The number of ascospores depends on the amount of inoculum in the overwintering leaves — that is whether it is a low or high inoculum orchard. The rate at which ascospores mature in the overwintering leaves on the orchard floor is determined mainly by temperature.

Cornell University developed a model relating temperature to spore maturation (expressed in degree–days Celsius or DDC). The model allows one to predict the percentage of the season's ascospores that have matured. (See Figure 7–2, *Cumulative Percentage of Ascospores Matured at Various Degree–day Accumulations*.) Daily accumulated degree–days are calculated as follows:

$$\text{DDC} = (\text{Daily max. } ^\circ\text{C} + \text{Daily min. } ^\circ\text{C}) / 2 - 0^\circ\text{C}$$

For example, on a day with a high of 10°C and a low of 2°C, the daily accumulated degree–days will be 6 DDC. If temperatures are below freezing, (i.e., minus number) then use a value of 0 DDC. The daily degree–day accumulations should begin at *bud break*, which is defined as the day on which at least 1/2 of the fruit buds on McIntosh are between silver tip and green tip.

The daily degree accumulations are used to estimate the percentage of mature ascospores from the central curve in Figure 7–2. The upper and lower curves in Figure 7–2 are the upper and lower 90% confidence limits on the estimates from the graph.

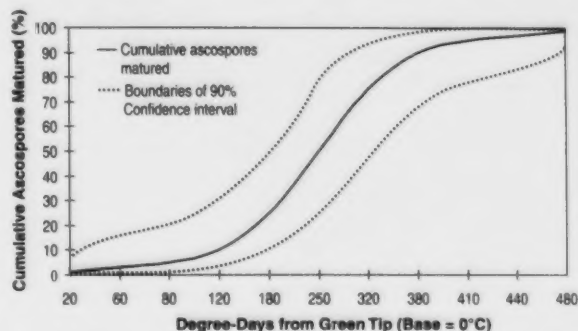


FIGURE 7–2. Cumulative Percentage of Ascospores Matured at Various Degree Day Accumulations

The width of the 90% confidence interval is a statistical measure of the precision of estimated maturity. The estimate should fall within this range 90% of the time.

Two points of particular interest on this graph are:

- At 125 DDC – there is a rapid maturation of ascospores indicating a higher risk of infections occurring.
- At 418 DDC – over 95% of the ascospore supply should be depleted 90% of the time if sufficient rain events have occurred (see Table 7–7, *Percentage of Available Ascospores Discharged Under Various Environmental Conditions*). This marks the end of the primary infection season. With this model the grower can obtain a site–specific forecast of ascospore maturity and discharge for their own orchard(s).

TABLE 7–7. Percentage Of Available Ascospores Discharged Under Various Environmental Conditions

Type of Rain Event	% Available Ascospores
Night rain only	5%
Day rain < 0.25 cm; < 10°C	25%
Day rain > 0.25 cm; < 10°C	50%
Day rain < 0.25 cm; > 10°C	50%
Day rain > 0.25 cm; > 10°C	90%

#### 2. Ascospore release

Ascospores are released when there is rain to wet the pseudothecia on the dead leaves. Most of the available mature spores are discharged within 2 hours after the start of a rainy period. Ascospore release is strongly light

dependent. Only a small percentage of available ascospores is released at night, from 7 p.m. to 8 a.m. Eastern Daylight Savings Time (EDST). Ascospores are not released to any significant extent during nighttime hours in low inoculum orchards. In an orchard where the ascospore inoculum is high, although the percentage of ascospore release is small, the total number of ascospores released is large and can cause significant primary scab.

In a low inoculum orchard, calculate the length of wetting period using the following method.

- When rain begins during the day, between 8:00 a.m. and 7:00 p.m. (EDST), count the hours of leaf wetness from the first hour rain was recorded until the leaves are dry.
- When the rain begins at night, between 7:00 p.m. and 8:00 a.m. EDST, count the hours of leaf wetness from 8:00 in the morning until the leaves are dry.

For a high inoculum orchard, calculate the length of wetting period from the start of the rain until the leaves are dry, regardless of the time of day.

### 3. Available moisture

Rainfall is needed for the release of ascospores, and the leaves and fruit have to be wet in order for the infection to take place. The length of the wetting period required for infection varies with temperature. This relationship between hours of wetting and temperature is outlined in Table 7-8, *Relationship of Temperature and Moisture to Apple Scab Infection*.

Once the length of the wetting period has been determined, calculate the average temperature during this interval and check Table 7-8 to see if leaves were wet long enough for an infection to occur.

### Secondary Infection Periods

Secondary scab infections occur when conidia developed from primary scab lesions on leaves are spread by splashing rain. As with primary infections, secondary infections only occur if moisture initiated by rainfall is present for a long enough period at a given temperature. Secondary infections can occur day or night so all secondary infections are calculated from the beginning of the wetting period regardless of the time of day. Continued infections through the summer result from lesions caused by conidia.

### Contribution of Intermittent rain and dew to infection periods

Periods of dew or high humidity (over 90%) also contribute to a wetting period, but are significant only if preceded by rain. Wet periods during an intermittent rain should be added together to determine the length of an infection period, unless the wet periods are separated by 10 hours or more of dry, sunny weather.

### Fruit infection

As the fruit matures it takes a progressively longer wetting period for infection by apple scab to occur. Table 7-9, *Relationship of Temperature, Hours of Wetting and Weeks after Full Bloom to Secondary Apple Scab Infection of Fruit*, outlines this relationship.

**TABLE 7-8. Relationship of Temperature and Moisture to Apple Scab Infection**

Average Temp. (°C)	Minimum Number of Hours of Leaf Wetness Required	
	Primary Season (Ascospore Infection)	Secondary Season (Conidia Infection)
1	40	37
2	34	33
4	27	26
5	21	23
6	18	20
7	15	17
8	13	15
9	12	13
10	11	12
11	9	10
12	8	9
13	8	9
14	7	9
15	7	9
16	6	9
17	6	8
18	6	8
19	6	8
20	6	7
21	6	7
22	6	7
23	6	8
24	6	9
25	8	11
26	11	14

From: Stensvand, Gadoury, Amundsen, Semb and Seem, 1997  
Phytopathology 87: 1046-1053



**TABLE 7–9. Relationship of Temperature, Hours of Wetting and Weeks after Full Bloom to Secondary Apple Scab Infection of Fruit<sup>1</sup>**

Average Temp. °C	Weeks After Full Bloom			
	1	5	10	15
	Hours of Wetting for 2% Fruit Infection			
10	13	26	37	45.5
12	10	21.6	31	38
14	8.5	18.5	26.5	32.5
16	7.5	16	23	28.5
18	6.5	14.5	20.5	25.5
20	6	13	18.5	23

<sup>1</sup> Adapted from Schwabe et al., 1984

Cultivars tested were: Golden Delicious, Starking Delicious, Starkrimson Delicious, White Winter Pearmain.

Wetting periods required for infection of fruit by the scab fungus are longer than those required for leaf infection. For orchards with only light primary leaf infection, the longer infection times required for fruit may be followed in those orchards where only fruit scab is of concern. If unchecked during the growing season, leaf infection could create large amounts of overwintering scab inoculum and heavy ascospore release the following year.

## Apple Scab Management with Fungicides

Chemical control of apple scab by fungicides is the most common and successful method of controlling this disease on commercial cultivars. Table 7–10, *Characteristics of Apple Scab Fungicides*, outlines registered fungicides and their efficacy on scab and other apple diseases. Understanding the characteristics and activity of the fungicides available is essential for using them successfully.

Here are some definitions of fungicide activity.

- **Protective activity** — the ability of fungicide residues to inactivate and kill fungal spores, thereby preventing infection.
- **Pre-symptomatic (after-infection) activity** — a fungicide which will prevent scab lesions being established once the infection has occurred, when it is applied within the period given in Table 7–10.
- **Post-symptomatic (curative) activity** — fungicide's ability to prevent or greatly inhibit the further production of secondary spores (conidia) when applied to sporulating secondary scab lesions. Generally, applications of fungicides with eradicant activity must be repeated for best effect.

## Early Season Management

Primary scab management programs are based primarily upon timing and the type of fungicide being used. There are 2 general approaches.

### Protectant fungicide program

This program is based on applying and maintaining fungicide on expanding foliage before infection periods occur. Begin the program just before the first anticipated primary infection period (between silver tip and green tip). Apply fungicides when infections are imminent, preferably just before each expected primary infection period.

- The exception is when using sterol-inhibiting fungicides where a 7–10 day spray schedule, regardless of rainfall, is used.
- From first cover until early August, apply fungicides at 10–14 day intervals depending on rainfall frequency. New growth and expanding fruit must be protected and residues washed off by rain must be replaced.
- Some fungicides are not readily washed off and the residues are redistributed by rainwater (Table 7–10).

### Pre-symptomatic (after-infection) sprays

An after-infection spray is one applied within a specific time after the start of an infection period. The time available to apply the fungicide effectively depends on the product used and the average temperature (see Table 7–10). When calculating after-infection activity, you must start counting the time interval from the beginning of the infection period. For example, at 6°C you would have to apply captan within 48 hours from the beginning of the infection period.

- Do not rely on pre-symptomatic (after-infection) fungicide programs to control scab. In order to use this type of spray program successfully, equipment capable of providing good spray coverage under adverse conditions is necessary. Reliable and accurate temperature and leaf wetness monitoring equipment for each orchard is a must when relying on pre-symptomatic activity of fungicides to control scab.
- After-infection sprays are usually considered emergency treatments to be used when the regular protectant program has been weak or ineffective, or scab is present on the trees. However, these programs may be used effectively by some growers on processing and juice blocks.

### Use of Sterol-Inhibiting Fungicides

Nova 40WP and Nustar are members of the sterol inhibitor (SI) group of fungicides. These products must be used in a manner different from the protectant fungicides, such as captan or mancozeb.

SI fungicides are systemic and must be absorbed by the leaf and fruit tissue to be effective. SI's will be absorbed within 1 hour of application and effectiveness will not be reduced if rain occurs more than 1 hour after application.

SI fungicides do not redistribute well after application. Therefore, uniform spray coverage is essential for good disease control.

The main strength of the SI group of fungicides is their relatively long post-infection pre-symptom activity. The SI's can cure new scab infections if applied within 72–96 hours after infection. The SI fungicides, however, generally have only 3–5 days of protective ability.

To maximize post-infection and pre-symptomatic (after-infection) activity, a second spray must be applied within 7–10 days following a post-infection application. If this interval is exceeded a third application may be necessary 7–10 days later.

Resistance has developed to the SI fungicides in other countries, where multiple applications were made each season for several years. Therefore, to minimize or delay the development of SI-resistant apple scab in Ontario orchards, it is recommended that Nova 40WP or Nustar be mixed with a protectant fungicide (e.g., mancozeb or captan). Limit the number of applications to no more than 4 per season. Do not use Nova 40WP or Nustar when scab lesions are present, because this may encourage the development of SI resistant strains of scab.

TABLE 7-10. Characteristics of Apple Scab Fungicides\*

Product/1000L	Protectant Activity (Pre-infection)	Max. after infection <sup>1</sup> Activity (hr)			Post-Symptom Activity	Retention (50 mm rain)	Redistribution (12 mm rain)
		6°C	12°C	17°C			
Benlate 50WP (0.5kg)	F	48	24	18	VG	G	P
Captan 50WP (2 kg)	VG	48	24	18	N	VG	G
Dikar WP (2 kg)	VG?	48	24	18	VG	E?	VG?
Dithane M45/80 WP (2kg)	VG	48	24	18	N	E	VG
Equal 65WP (0.5 kg)	VG	48	24	18	VG	VG	VG
Manzate 200 (2 kg)	VG	48	24	18	N	E?	VG
Nova 40 WP (140g) <sup>2</sup>	F	96	96	96	F–G	F?	F?
Polyram 80 WP (2kg)	VG	48	24	18	N	E?	VG

\* Data is adapted from New York (Geneva) from work done by Szkolnik et al, using conidia. These values are adapted from greenhouse tests on Golden Delicious. Rate per hectare is 3 times rate per 1000 L. The after-infection activity of these fungicides may not be adequate to control primary scab in commercial orchards. Do not rely solely on after-infection activity for the control of apple scab.

These results are formulation specific. Newer formulations of some products have not been evaluated (e.g., Dithane DG, Polyram DF, Manzate 200DF). Contact the manufacturer for more information.

<sup>1</sup> Maximum after-infection activity is calculated from the start of the infection period.

<sup>2</sup> Data on Nova is adapted from 1993 *Pest Management Recommendations for Commercial Tree Fruit Production*, Cornell Co-operative Extension, New York

KEY: E=excellent; VG=very good; G = good; F=fair; P=poor; N=none. Values followed by (?) are based on field observations.

Make the season's first application only when there is sufficient leaf tissue for absorption. Prior to tight cluster, there may not be enough tissue for maximum absorption.

Always use Nova 40W or Nustar in groups of 2–3 consecutive sprays.

Alternating between Nova 40WP and Nustar is not recommended since they have similar modes of action.

**Do not apply sterol-inhibiting fungicides when scab lesions are present because this encourages resistance development.**

### Control Under Adverse Weather Conditions

Several consecutive days of continuous wet conditions and mild temperatures are common in the spring. These conditions are favourable for apple scab infection. It is often difficult to maintain sufficient fungicide on the trees to provide protection for the rapidly expanding foliage and fruit under such conditions.

If you feel your trees are not protected, it is better to apply a protectant-type fungicide during a break in the rain, than not to spray at all. Use a fungicide with good retention properties. For example, Mancozeb has good retention activity, while Benlate has poor retention when applied to wet trees.

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit. Benlate has antispore activity beyond the stated after-infection activity period when resistance is not present (see Table 7–10). Repeat application in 4 or 5 days if wet weather persists.

If an infection has occurred, scab lesions should become visible on the foliage and fruit in about 9 days at 20°C or in about 14–21 days if the average temperatures are 12°C or lower.

Control these infections as soon as they become visible by following the instructions outlined in the following section on *Deactivation of Established Scab Lesions*.

Strong winds can hamper spraying operations by causing pesticides to drift away from the intended target. Spray at night or early morning to help reduce spray drift. Lowering the spray trajectory into the wind may also help, but take

extra care to make sure that the treetops get good spray coverage.

### Deactivation of Established Scab Lesions

Apple scab lesions that are visible on the foliage and fruit can produce many spores capable of spreading the disease through secondary infection. Several fungicides have good post-symptomatic (curative) activity (Table 7–10). However, benomyl (Benlate), thiophanate-methyl (Senator) and dodine (Equal) have not been effective where resistance to these fungicides is present. Resistance to these fungicides is widespread in Ontario apple orchards.

If fungicide resistant scab is not present in your orchard and apple scab lesions are visible, you can try to deactivate these tissue infections. Two sprays of a post-symptomatic fungicide should be applied at the full rate 5–7 days apart as soon as scab lesions are observed. These materials reduce the number of spores produced on the lesions and should help to slow the spread of the disease. Follow with a regular season-long protectant program.

### Secondary Scab Management

By using the degree day model, the end of primary season can be determined. At 418 DDC, over 95% of the ascospores are mature, and after a significant rain event all of the ascospores have been discharged for the season. (See Table 7–7 on page 59.) After this point, wait 2 weeks before checking your trees to see if scab is present. It can take up to 14 days for lesions to appear following a scab infection period. Make sure you check in the top of standard trees or anywhere else where you feel that spray coverage may not have been adequate, e.g., thick tree canopy.

If primary scab has been controlled in your orchard, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season. Some growers have successfully eliminated all use of fungicides during the summer months where primary scab was avoided. If scab lesions are found, maintain a fungicide program for the remainder of the season.

### Fire Blight of Apple

Fire blight can be a major disease problem for Ontario growers. The following practices, used together, can help reduce blossom and shoot blight infection in susceptible cultivars. For detailed information on biology and management of fire blight, see OMAFRA Publication 310, *Integrated Pest Management for Ontario Apple Orchards*.

## Predicting Fire Blight Infections

Maryblyt is a computer modeling program. It is designed to predict fire blight infection by using daily minimum and maximum temperatures, rainfall amounts and wetness resulting from heavy dew and by inputting forecasted weather. Advanced warning (1–4 days) of fire blight infection is provided during the critical susceptible growth stages. The most precise prediction for your farm is obtained when you collect and input your own data using Maryblyt. Copies are available from Gempler's Pest Management Supply, P. O. Box 270, Mt. Horeb, WI., 53572 USA. Telephone: 1-800-272-7672 or 1-608-437-4883; or FAX 1-800-551-1128.

## Cultural Practices

- Make use of tissue and soil analysis to avoid applying excessive amounts of nitrogen fertilizer in the spring. Succulent, rapidly growing shoots and suckers are more susceptible to fire blight infection.
- Remove all diseased wood in the dormant season, in January or February when temperatures are below freezing. Patrol orchards at least twice per week when blossom and shoot blight symptoms are predicted to occur. It is practical to remove these new infections from the orchard when the number of strikes is low to avoid further spread of the disease.
- New infections must be pruned out at least 30–45 cm below discolored wood using pruning tools. A new approach, especially successful on apple, involves leaving a stub of wood 2 years old or older during the growing season and coming back to prune this stub out during the dormant period. Leaving a stub allows the fire blight to form a localized canker, allowing the tree to seal it off, and preventing the infection from extending further into a main limb.
- Pruning tools can be disinfected with household bleach (6% sodium hypochlorite solution) by mixing 1 part household bleach in 4 parts water. Store bleach solution in a well labeled closed plastic or glass container. After use, wash tools and oil them to prevent rust. Denatured alcohol (ethanol) is a better disinfectant than the bleach solution and will not rust tools.
- In intensively managed orchards, it may be practical to remove secondary blossoms on apple cultivars such as Golden Delicious and Paulared before they become infected.

## Chemical Control

- In spring, warm temperatures (18°C or greater) and moisture (rain, or heavy dew) favour infection of blossoms. When these conditions are predicted, and they persist through the blossom period, protect the blossoms with Streptomycin 17 at 100 ppm (100 ppm = 600 g product/1000L).
- Spray during slow drying conditions. Spray is most effective when applied dilute (high volumes of water) prior to a wetting period. For best results use Streptomycin 17 alone in the tank.
- Because it is sensitive to ultraviolet light, Streptomycin 17 is effective for only 2–3 days. Reapplication is also needed to protect newly opened blossoms, after 2–3 days, if warm, wet conditions (above 18°C) prevail. Two to 4 sprays during the bloom period may be necessary to protect blossoms against fire blight infection.
- In non-bearing orchards, copper sprays may be substituted for Streptomycin 17. However, copper sprays are less effective than Streptomycin 17 for controlling fire blight. Mix copper sprays with lime according to label directions. For more information on registered formulations, rates and mixing instructions see *Use of Copper Products on Fruit Crops*, page 34.
- If hail or damaging winds occur during the growing season, apply Streptomycin 17 within 12 hours to prevent trauma blight causing serious damage to the trees and crop. Beyond 24 hours, streptomycin is not effective. Ensure a 50-day to harvest interval on apple.

**Excessive use of Streptomycin 17 may lead to fire blight resistance developing.**

For best results, all of these cultural and chemical control methods should be used together to keep fire blight at a manageable level in the orchard.

## Phytophthora Collar Rot Control

Collar rot arises where heavy soil, poor drainage, or replanting in old orchard sites occurred. This disease, caused by a long-lived, soil-borne fungus (*Phytophthora cactorum*), is especially damaging to apple trees grown on MM.106 rootstock. Trees on M.26 and M111 rootstocks are intermediate in susceptibility, while M7A and M9 rootstocks are moderately resistant.



Where concern for collar rot is present before planting, do not plant susceptible rootstocks.

For problem areas, Ridomil Gold 480 EC is registered for use on non-bearing trees only. Apply Ridomil Gold 480EC as a drench to the soil around the base of the tree. Use 1 mL in 5 L of water per tree. Make the first application at planting and repeat in late August. In subsequent non-bearing years, apply Ridomil Gold 480EC in the early spring and again in late August. This treatment will suppress fungal growth and development. However, the fungus will survive in the soil. Long-term control should include resistant rootstocks and proper site selection.

## Blue Mould and Gray Mould in Stored Apples

Under certain conditions rot can develop on apples during storage. Disease organisms are common in and around grading lines, work areas and storages. Fungi causing blue mould (*Penicillium*) and gray mould (*Botrytis*) are spread in air currents and by water.

Infection of apples most commonly occurs after harvest through stem punctures, wounds, skinbreaks and heavy bruises. These fungi can be transferred from contaminated bins, water used for dipping or drenching, and grading equipment.

Rot will develop faster if the infected apples are delayed going into storage, are cooled slowly in storage, are stored for a longer period, or are held at warm temperatures after removal from storage.

### Reducing Disease Development

Careful handling during and after harvest to minimize stem punctures, skin breaks and bruising can greatly reduce the number of infection sites on the fruit.

At the storage, lift truck operators must also move the bins with a minimum of jolting and dropping. Refrigerate the

fruit as quickly as possible. Adequate refrigeration capacity for each storage room is required. Modern refrigeration facilities and the use of CA atmospheres also reduce the development of fruit rot.

Sanitation in the handling/grading area is most important. Careful and frequent removal of rotted fruit from the premises and disposal off the property will greatly reduce the dispersal and spread of disease organisms within the building.

Frequent changing of the water used for dipping or drenching will reduce the accumulation of fungal spores in the water, greatly reducing the risk of fruit infection.

### Post Harvest Treatment

Thiabendazole (TBZ) can reduce disease incidence. A formulation called Mertect 45% F is registered in Ontario to control the development of *Penicillium spp* (e.g. blue mould) and *Botrytis cinerea* (e.g. gray mould) on stored apples and pears. Mertect 45% F can be used as a post harvest dip or drench. The rate is 0.5 L of product in 500 L of water. Certain precautions must be followed.

- Constant agitation is required to maintain a suspension during treatment.
- Mertect must be in direct contact with the skin of the fruit. Do not apply wax prior to Mertect treatment.
- Consult the label for additional instructions.

Research and field experience indicates that resistant strains of these diseases are common. Resistant strains are not controlled by treatment with thiabendazole.

However, the addition of diphenylamine (DPA) to reduce storage scald in the post harvest treatment is reported to control some resistant strains of blue mould (*Penicillium*) and gray mould (*Botrytis*).



TABLE 7-11. Effect of Fungicides on Apple Diseases\*

Fungicides	Apple Scab	Powdery Mildew	Cedar-Apple Rust/Quince Rust	Black Rot	Bitter Rot	Sooty Blotch	Fly Speck
captan (captan, Maestro)	+++	0	0	+++	++	+++	++
benomyl (Benlate)	++R	+R	0	+++	++	+++	+++
thiophanate-methyl (Senator)	++R	+R	0	+++	++	+++	+++
myclobutanil (Nova)	++	+++	+++	+	0	0	0
flusilazole (Nustar)	+++	++	?	?	?	?	?
cyprodinil (Vangard)	++	+	0	?	?	?	?
copper	+	+	+	+	+	+P	+P
dithane+ karathane (Dikar)	+++	+++	++	+	+	+++	+++
mancozeb (Dithane, Manzate, Penncozeb)	+++	0	++	0	+	+++	+++
metiram (Polyram)	+++	0	++	0	+	+++	+++
sulfur	+	++	+	0	0	0	+

R = Pathogen resistance (insensitivity) present to the fungicide.

P = Phytotoxic, causes russetting

0 = no control

+ = poor to fair control ++ = good control, some limitations

+++ = excellent control, few if any limitations

? = efficacy unknown

This table was developed by the IR-4 Project through discussion at the annual meeting of the Deciduous Tree Fruit Diseases Workers in August, 1999.

\* Use fungicides only for control of diseases listed on the product label.

## Thinning and Growth Regulators

### Chemical Thinning of Apples

Thinning of apples is required to improve overall fruit size and finish, create more uniformity in the crop and to encourage return bloom. The sooner you accomplish thinning after the bloom to fruit set period, the greater the potential for increasing fruit size. The objective is to reduce clusters to single fruitlets (preferably king bloom fruitlet). Thinning needs are based on grower experience, taking into account the cultivars involved, fruit sizes required, strength of bloom, bee activity and weather conditions during pollination. The previous thinning history should be well documented. A well-thinned crop will have better colour and pick more easily at harvest.

### Chemicals Available for Thinning

Accel® is an altered form of Promalin® containing the growth regulator benzyladenine (BA), which is the active ingredient for thinning, and gibberellin A4+7. Accel is registered for use in Canada at the rate of 2.5–4.0 L/ha, which is equivalent to 49 g to 74 g BA/ha. The use of Accel is limited to two sprays, each containing no more than 74 g BA/ha. Since the label is based on a per hectare basis,

the maximum concentration applied depends upon the tree size and volume of water used to obtain good coverage. Research at the Simcoe Horticultural Experiment Station and elsewhere indicates that the concentration of BA in the spray solution is also important. Concentrations below 50 ppm BA are generally ineffective for thinning or improving fruit size.

Accel is not a satisfactory thinning compound for all cultivars but has exhibited effectiveness for Empire, McIntosh, Idared, Gala and others. See Table 7-14, *Suggested Rates for Chemical Thinning of Mature Apple Trees*<sup>1</sup>, on page 71.

Unlike other chemical thinners currently available in Canada (NAA and carbaryl), Accel has the potential to improve fruit size independent of thinning. This is accomplished by increasing cell division shortly after flowering during the early stages of fruit growth and development that may translate into larger fruit at harvest.

The window of best response for Accel is between 5–12 mm fruitlet size.

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**IMPORTANT NOTE CONCERNING THE FOLLOWING  
PAGES**

**THE PAGES WHICH FOLLOW HAVE BEEN FILMED  
TWICE IN ORDER TO OBTAIN THE BEST  
REPRODUCTIVE QUALITY**

**USERS SHOULD CONSULT ALL THE PAGES  
REPRODUCED ON THE FICHE IN ORDER TO OBTAIN  
A COMPLETE READING OF THE TEXT.**

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**REMARQUE IMPORTANTE CONCERNANT LES  
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**LES PAGES SUIVANTES ONT ÉTÉ REPRODUITES EN  
DOUBLE AFIN D'AMÉLIORER LA QUALITÉ DE  
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**LES UTILISATEURS DOIVENT CONSULTER TOUTES  
LES PAGES REPRODUITES SUR LA FICHE AFIN  
D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL**

Accel should be applied dilute in 500–1000 L of spray solution per hectare. Uniform and thorough coverage is essential.

#### Precautions

Do not apply Accel in combination with the hormone thinners NAA (Naphthaleneacetic acid) or NAD (Naphthaleneacetamide) either as a tank mix or separate sprays during the same growing season, as this may result in the formation of pygmy fruit.

#### Environmental Conditions

To optimize plant uptake of the spray solution, apply Accel during periods of slow drying (for example, early morning). Best results are obtained when warm temperatures (greater than 20°C) occur during and following application. Always read the label before using.

#### Spray Concentration

After determining the concentration of BA to use, it is important to then determine the water volume required to wet the foliage just to the point of runoff. After this has been determined use Table 7–12, *Accel® Rate* to determine the volume of Accel to add to deliver the correct amount of BA in the correct concentration to be effective.

NAD (Naphthaleneacetamide), such as AMID THIN is a hormone-type material that is absorbed by foliage, where it induces formation of the abscission layer between the spur and the fruit. NAD is a relatively safe material that is applied at first petal fall; i.e. petals on the king blossom are

falling. The concentration will vary from 50–100 ppm, depending on variety and growing conditions. Used at the proper timing it is particularly effective on hard to thin varieties such as Golden Delicious. This hormone-type material is mostly absorbed from the original solution. Once dry, the effect it has on thinning is over. Therefore large water volumes applied under slow drying conditions are recommended. Weather that promotes soft, succulent and rapid growth will lead to increased absorption. Avoid windy, cool, fast drying conditions. Temperatures between 21°C–24°C are considered optimum.

NAA (Naphthaleneacetic acid), such as FRUITONE–N, is a hormone-type thinner that is absorbed primarily through the leaves. It works as a growth regulator affecting auxin activity and interfering with proper fruit development by accelerating ethylene biosynthesis. The fruitlet being thinned usually drops within 10–14 days after spraying. NAA needs to be dissolved in water in order to be absorbed by the foliage. Almost all NAA is absorbed from the original solution. Once dry, the thinning effect is stopped. Thus, larger volumes of water used under slow drying conditions are recommended when applying NAA. The longer the time required to dry the spray and the higher the drying temperatures, the greater the absorption of the NAA. NAA also has a short life due to breakdown by sunlight. The most effective time to apply is under warm, dull, slow drying conditions. The preferred time is in the morning when the trees are damp, drying is slow, and the temperature is on the rise. The material is absorbed and the tree has an immediate growing day to utilize the thinner. NAA is considered to be rain fast after 2–3 hours.

TABLE 7–12. *Accel® Rate*

The relationship between spray water volumes required to thoroughly wet trees, grams active ingredient (BA) per hectare, and concentration of BA and per hectare rate of Accel ®.

Spray Volume required to thoroughly wet trees (litres/ha)	grams BA per hectare				
	25	37	49	62	74
	litres of Accel per hectare				
	1.3	2.0	2.6	3.3	3.9
Concentration of BA in parts per million (ppm)					
200	124	185	247	309	371
300	82	124	165	206	247
400	62	93	124	154	185
500	49	74	99	124	148
600	41	62	82	103	124
700	35	53	71	88	106
800	31	46	62	77	93
900	27	41	55	69	82
1000	25	37	49	62	74

Concentrations of BA in shaded area not recommended.



Accel should be applied dilute in 500–1000 L of spray solution per hectare. Uniform and thorough coverage is essential.

### Precautions

Do not apply Accel in combination with the hormone thinners NAA (Naphthaleneacetic acid) or NAD (Naphthaleneacetamide) either as a tank mix or separate sprays during the same growing season, as this may result in the formation of pygmy fruit.

### Environmental Conditions

To optimize plant uptake of the spray solution, apply Accel during periods of slow drying (for example, early morning). Best results are obtained when warm temperatures (greater than 20°C) occur during and following application. Always read the label before using.

### Spray Concentration

After determining the concentration of BA to use, it is important to then determine the water volume required to wet the foliage just to the point of runoff. After this has been determined use Table 7–12, *Accel® Rate* to determine the volume of Accel to add to deliver the correct amount of BA in the correct concentration to be effective.

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TABLE 7–12. *Accel® Rate*

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	litres of Accel per hectare				
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200	124	185	247	309	371
300	82	124	165	206	247
400	62	93	124	154	185
500	49	74	99	124	148
600	41	62	82	103	124
700	35	53	71	88	106
800	31	46	62	77	93
900	27	41	55	69	82
1000	25	37	49	62	74

Concentrations of BA in shaded area not recommended.



NAA is not effective at temperatures less than 10°C. NAA can result in leaf flagging (wilting) but these leaves recover in a few days.

**Carbaryl (Sevin):** In the early 60's the insecticide "Sevin" with the active ingredient carbaryl was discovered to have fruit thinning properties. Carbaryl is absorbed primarily through the fruit, not the foliage. The presence of carbaryl in the vascular system of the fruitlet interferes with biochemical processes. Certain important fruit growth processes cease, and the fruitlet drops. This fruitlet drop usually starts 5–10 days after application. Thinning with Sevin increases regularly with concentrations up to 1.0 kg active carbaryl (2.0L Sevin XLR Plus)/1000 L of water. There may be little or no increase in thinning with higher concentrations. Carbaryl is relatively insoluble in water and low concentrations produce a saturated solution. This insolubility is a limiting factor in its effectiveness because absorption by the fruitlet is limited to materials in true solution. It is an advantage however, in that the hazard of over thinning, through error in concentration, is reduced. **Surface residues of the XLR Plus formulation of Sevin (unlike the 50W formulation) do not provide additional thinning effects** when rain or dews cause re-wetting of the tree canopy. Sevin, although the easiest and safest thinner to use, can be harsh on beneficial insects and mite predators, if present, depending on amounts used.

**1L of Sevin XLR Plus contains approximately the same amount of active ingredient (carbaryl) as 1 Kg of Sevin 50 W**

**Carbaryl (Sevin) plus NAA:** This combination has been used on hard-to-thin cultivars such as Paulared, Golden Delicious, Fuji and Gala strains, with considerable success. A constant rate of 1 L Sevin XLR Plus (product) per 1000 L of water should be used with varying rates of NAA from 3–15 ppm. Because NAA only has one chance to work, higher water volumes are recommended.

### Length of Wetting Period for Material Absorption

Sprayed trees should be visibly wet for a minimum of 30 minutes for effective absorption of thinners to take place. The best time of day to apply thinning sprays is at the beginning of the daylight hours when air temperatures are above 10°C and climbing, and when the trees are becoming more physiologically active. Spray before the wind comes up in the orchard, as wind accelerates drying time and could blow thinners off target.

## Factors Influencing Response to Thinning Agents

### 1. Cultivar sensitivity (mature trees)

**Easy-to-thin** cultivars include non-spur Red Delicious, Idared, Crispin (Mutsu), Jonagold strains, Jersey mac.

**Moderately difficult** cultivars include Empire, McIntosh, Northern Spy, Cortland.

**Harder-to-thin** cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

### 2. Weather conditions

Certain weather conditions may increase the thinning response by permitting greater absorption of chemicals:

- cool, wet weather and low light conditions before or after application
- prolonged period of high humidity without rain either before or after application
- high temperatures following cool periods
- frost or near-freezing temperatures before or shortly after application
- a prolonged period of dry weather before application.

### 3. Pollination and bee activity

These activities are tied in closely with weather conditions. Pollinating conditions and bee populations may render fruit either more or less difficult to thin. Fruit that is set under good pollinating conditions and results in increased seed count is harder to thin. Fruit that is set on king blossoms is more difficult to thin than fruit set on side blossoms. Single fruit are more difficult to thin than clustered fruit. A light or spotty set, with clustered fruit, should be thinned but at low rates in order to break up the clusters.

### 4. Tree age and vigour

- Young trees are more easily thinned than mature trees that have cropped well for 2–3 yrs. Hand-thin young trees of high-value cultivars that do not have a settled cropping pattern. Low rates of thinners that work on mature trees can easily over-thin young trees.
- Mature trees that are low in vigour, for whatever reason, are more easily thinned.
- Trees bearing a heavy crop one year and having good bloom the following year may be more easily thinned.
- The heavier the bloom, the more stress on the tree and the easier to thin.

- The more stress from the previous season, e.g. excessively dry or excessively wet, nutritional deficiencies, insects or disease, then the easier to thin.

### 5. Density of foliage

- Poorly pruned dense trees are thinned more easily than well-pruned open trees.
- Lower, partially shaded, branches of well-pruned trees are thinned more easily than upper branches because of weaker spurs.

### Timing of Application

Application timing varies with the chemical used. NAD is applied during early petal fall (see NAD section above). The best timing for application of NAA, Sevin, and NAA + Sevin combinations is usually 7–12 days after petal fall<sup>1</sup> (early cultivars are an exception, see Table 7–14, *Suggested Rates for Chemical Thinning of Mature Apple Trees*<sup>1</sup>, on page 71). Use 7 days if it is warm and 12 days if it is cool. Sevin can be effective as a thinner when applied up to 21 days after petal fall. NAA is only effective as a thinner if applied up to 12 days after petal fall. NAA applied too soon (bloom to petal fall period) can result in excessive thinning. NAA applied too late can result in reduced fruit size and, in severe circumstances, pygmy fruit.

For some cultivars, a size relationship for applying chemical thinners based on the average fruitlet diameter has been established. See Table 7–13, *Suggested Timing of Thinning (NAA)*. When the largest fruitlets (preferably the king bloom fruitlet) have reached the diameter stated, the fruitlets which are smaller and weaker should drop off if the thinner is effective. This relationship works best when the king bloom fruitlet is larger than the side bloom fruitlets and when the size and stage of development of all the fruit to be thinned is fairly uniform.

### Sampling Method

A total of 50–60 fruitlets of each cultivar should provide a good estimate of fruit development in a reasonably uniform orchard block. Select the 2 largest developing fruits from each of 25–30 randomly selected clusters. Measure the greatest diameter of each and determine the average for the sample. Vernier calipers or a thinning template provide a simple means for taking measurements rapidly and accurately.

1. Petal fall — when 80% of the petals have fallen off but before calyx lobes are closed.

TABLE 7–13. Suggested Timing of Thinning (NAA)

Cultivar	Diameter of largest fruitlets in cluster
McIntosh	8.0–9.5 mm
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Northern Spy	10.0–11.0 mm
Empire, Idared, Jonagold	8.0–10.0 mm
Gala, Golden Delicious, Fuji	8.0–9.0 mm

### Steps in Thinning

1. Determine how much thinning is required by looking at the orchard factors and assessing fruit load potential. Sepals (calyx leaves) on unpollinated bloom have a tendency to stay open or bend back. Successful pollination and fruit set results in sepal movement and closure.
2. Determine the material to use and the concentration or strength of the thinner required.
3. Determine the water volume required to effectively wet the trees. Dilute water volumes are recommended when applying all chemical thinners. In single row orchards, as the tree size becomes small and the number of trees per hectare increases, the volume of canopy that must be sprayed may become less. The average tree on M26 (3–3.5 m tall) at a density of 720 trees/ha (300/ac) may require more than 2 L. of spray/tree to thoroughly wet it at the time of thinning. The “Tree Row Volume” concept of calculating dilute water volumes is an accepted way to calculate required volumes. See OMAFRA Factsheet, *Guide for Spraying Tree Fruits*, Order No. 93–121. Some calibration work may have to be done on small groups of trees to determine just how much volume is required to thoroughly wet individual trees.

#### BEE WARNING

When Sevin is used in fruit thinning, extensive bee kills can occur if weeds or legumes are blooming in the ground cover. To reduce the chance of poisoning, remove bees from the orchard prior to treatment. Do not spray when the wind will carry Sevin to adjacent weedy or crop areas in bloom. Sevin XLR Plus is much safer to use than Sevin 50W around honey bees. Advise local beekeepers of your spraying activity.

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**Harder-to-thin** cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

### 2. Weather conditions

Certain weather conditions may increase the thinning response by permitting greater absorption of chemicals:

- cool, wet weather and low light conditions before or after application
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## Cultivar Notes

### *Empire*

Some growers are experimenting with application of NAA during the bloom period. Before applying NAA during the bloom period, make sure the king bloom fruitlet is set. Check sepal posture. Petal fall of king bloom can take place as early as 3–4 days past peak pollination. If NAA is used too early (full bloom to petal fall), potential overall fruit size of unthinned apples may be reduced compared to a treatment at a stage when the king fruitlet is 8–10 mm in diameter.

### *Gala*

Gala is relatively difficult to thin successfully. On mature trees, the approach must be aggressive. Good results have been achieved using a combination of NAA and Sevin at the rates listed for Golden Delicious. Timing is suggested for king fruitlet at 8–9 mm. Overall fruit size potential is determined within 2 weeks following calyx. Clusters must be thinned to 1 fruitlet (king bloom) by mid to late June. A follow up hand thinning within 30 days past full bloom is normally required to further reduce crop load.

### *Jonagold*

This cultivar will thin relatively easily and has good size potential when clusters are thinned to singles. Most producers find they get adequate thinning with moderate rates of Sevin. Overcropping of Jonagold may result in very poor return bloom and fruit may not mature to a premium quality.

### *Fuji*

Unthinned Fuji will normally return very little bloom the following year. This cultivar exhibits strong biennial characteristics. Fuji must be thinned aggressively for best results. Mature trees will usually thin adequately with combinations of Sevin and NAA. Follow-up hand thinning is usually necessary to further reduce the number of king fruitlets. Excessive crop may prevent the fruit from maturing to premium quality.

## Suggested Rates for Chemical Thinning of Apples

The rates in Table 7–14 are suggested guidelines only. There is no substitute for personal experience. It is important that yearly records are kept on weather conditions, rates, etc., and above all, that some trees be left unsprayed to help assess the thinning response. Use only one of the suggested chemical treatments. For example, with Wealthy, apply NAD, or NAA, or Sevin, or the combina-

tion. Before altering or modifying a treatment that has proven to be effective in any situation the grower is advised to discuss this matter with someone knowledgeable.

## Defruiting Immature Apple Trees

In some cases, defruiting immature apple trees to encourage proper development can be desirable. Experimentation to date indicates a dilute spray of NAA at 15 ppm combined with Sevin XLR Plus at 1.5–2 L/1000 L water 5 days after petal fall, gives acceptable results. Well established, supported trees under minimal stress can carry some crop load in the second year following planting.

## Promalin to Improve Fruit Shape of Delicious

Promalin is a plant growth regulator used on Red Delicious apples. Promalin improves the “typiness” or shape of Red Delicious apples through elongation of the fruit and development of more prominent calyx lobes. Promalin contains a mixture of benzyladenine and two types of gibberellins. Careful timing of the application, close adherence to recommended label rates and complete coverage are essential for satisfactory results.

## Precautions

- Application at higher rates or volumes than those recommended on the label, or, the presence of weak or frost-injured flowers, may cause fruit thinning. Promalin usage may also increase the amount of thinning achieved with subsequent blossom thinning sprays.
- Where spur vigour is low or where the king blossoms have been damaged by frost, the fruit lengthening response to Promalin may be negligible.
- Do not apply Promalin if rain is expected within 6 hours.
- Do not apply when air temperatures are lower than 24°C (75°F) or greater than 32°C (90°F).

## Application Notes

- For optimum results, apply between full king bloom and early petal fall. Applications earlier or later are likely to produce unsatisfactory response.
- High relative humidity and slow drying conditions favour maximum absorption. Preferably, apply in morning or evening.



**TABLE 7-14. Suggested Rates for Chemical Thinning of Mature Apple Trees<sup>1</sup>**

(use ONE of the following:)

Cultivar	NAD ppm <sup>2</sup>	NAA ppm <sup>2</sup>	Sevin XLR <sup>2</sup> Plus L/1000L	Sevin XLR Plus +NAA ppm <sup>2</sup> per 1000L water	Accel (g BA/ha) <sup>3</sup>	Sevin XLR Plus (L/1000L water) <sup>2</sup> + Accel (g BA/ha) <sup>3</sup>
Lodi, Melba, Quinte, Yellow Transparent	50-75	—	—	1L + 10-15 ppm	—	—
Early McIntosh	75-100	—	—	1L + 5-10 ppm (at petal fall)	50-75	—
Jerseymac, VistaBella, Tydeman's Red	—	5-10	1-1.5	—	—	—
Paulared	50-75	12-15	1.0-1.5	1L + 10-15 ppm	75	1L + 50
Spartan, Russets	—	10-20	1.0-2.0	1L + 10-15 ppm	—	—
Cortland	—	5-10	—	1-2 L + 2.5-5 ppm	—	—
Non Spur McIntosh	—	5-10	1.0-2.0	—	50	—
Spur Type McIntosh	—	10-12	—	1-2 L + 2.5-5 ppm	50-75	1L + 50
Golden Delicious, Wealthy	75-100	10-20	1.0-2.0	1L + 5-10 ppm	75	1-2 L + 50
Red Delicious	—	2-8	0.5-1.5	—	—	—
Spur Type Red Delicious	—	5-10	—	1-2 L + 5-10 ppm	—	—
Idared	—	2-8	—	—	50	—
Empire	—	7-10	1.0-1.5	1L + 2.5-4 ppm	50-75	1L + 50
Spy, Crispin (Mutsu)	—	5-10	0.5-1.5	—	—	—
Jonagold	—	—	1.0-1.5	—	50-75	—
Fuji	—	—	—	1-1.5 L + 10-12 ppm	—	1-2 L + 50-75
Gala	—	10-12	—	1L + 5-10 ppm	75	1-2 L + 50

“—” indicates treatment recommendation not available

<sup>1</sup> The above rates are suggested for trees that have a settled cropping history. To chemically thin a first crop tree or trees that are considered to be immature is very risky.

<sup>2</sup> Sufficient water volume must be used to thoroughly wet trees. Trees should be sprayed to the drip and be visibly wet for a minimum of 30 min. See *Steps in Thinning* on page 69.

<sup>3</sup> Consult Table 7-12 to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective. 1L of Accel contains approx. 19 grams of BA.

**Note:** The rates for Sevin are amounts of product. Sevin XLR Plus is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl per litre. One L of Sevin XLR Plus is roughly equivalent to 1 kg of Sevin 50W. For actual amounts of NAD and NAA refer to the label of the product being used.

**Calculating Parts per Million (ppm)**  
1 ppm = 1 g active ingredient  
per 1000 L water

## Ethephon to Promote Fruit Colouring

Ethephon (Ethrel) has the following effects on trees and fruit, depending upon the time and rate of applications.

- Ethrel stimulates ripening, colour development, and fruit drop. The fruit may all be on the ground 1 week after spraying unless a suitable stop-drop is used. Two applications of naphthaleneacetic acid (NAA) are

required: 1 as a tank mix at the time Ethrel is applied and the second 5 days later. Apply the stop-drop at the normal rate recommended on the label.

- Spray just the number of trees that can be harvested over a 2 or 3 day period. Following the spray application the fruit will be ready to harvest within 5-10 days, depending on cultivar and air temperature. After spraying, check the maturity of the apples on a daily basis (e.g. pressure, starch, flavour, colour). A few trees sprayed at 3-4 day intervals would be easier to manage than a large number sprayed at one time. A market should be available for the treated apples before they are sprayed, especially with early cultivars.

- Rates of application depend upon the cultivar, date of application, tree vigour, temperature, weather conditions, and degree of response required. The response to Ethrel is a chemical reaction and as such is dependent upon temperature. For this reason early cultivars such as Jerseymac and Paulared require less material than later cultivars. On early cultivars use 0.75–1.5 L of Ethrel per hectare with sufficient water to wet the trees thoroughly. McIntosh requires 1.5–4.25 L/ha. The higher rate is used early in the season on trees that are high in nitrogen, or on trees that are poorly pruned. Lower rates may be advantageous nearer the normal harvest, on young, well-pruned trees, or on trees that are low in nitrogen.
- Best results are obtained when Ethrel is applied 2–3 weeks before you would normally begin harvesting. Be sure and apply Ethrel uniformly, since it will work only where the spray touches.

## Chemical Control of Preharvest Drop of Apples

Cultivars differ in their tendency toward pre-harvest drop. In this respect, McIntosh gives the greatest concern in Ontario.

Fruit drop tends to be greater with trees in which the nitrogen content is high during the late summer and with trees carrying a heavy crop. Hot days and warm nights just before and during harvest tend to increase the amount of pre-harvest drop.

Drop may also increase if trees are deficient in either moisture or the nutrients boron or magnesium. Trees heavily infested with spotted tentiform leafminer also have a greater tendency for preharvest drop.

NAA (naphthaleneacetic acid), such as FRUITONE-N, FRUIT FIX CONCENTRATE, is registered to control drop on apples. This is the same material used earlier in the season for thinning the crop. The concentration differs for the 2 purposes. Apply NAA as soon as the first sound apples begin to drop, at the rate of 10 ppm (single strength rate). Timing is important. Do not confuse the normal pre-harvest drop of sound apples with those that have been pushed off, or are dropping because of insect, disease, or nutritional deficiency.

NAA is effective for 7–10 days after spraying. Longer holding can be obtained by repeated application of a single strength rate every 7 days. If applied before any harvest has

taken place, it takes 1–2 days for NAA to take effect after application. If applied after the orchard has been spot picked it may take longer to take effect. Therefore, it is best to apply it as soon as you finish the spot pick. Do not apply NAA closer than 5 days before harvest. Refer to the label.

NAA is preferably applied in a dilute spray. A dilute application favours more uniform coverage, which is important because NAA is only locally systemic and high amounts of water slows drying rates for increased absorption. The optimum conditions for maximum absorption are at or near 21°C–24°C (70°F–75°F) and high humidity. Absorption is less on foliage injured by insects, diseases, or frost, and at temperatures below 16°C (60°F). The addition of a non-ionic type spreader sticker, e.g. Agral 90, will improve absorption of NAA under less than ideal weather conditions.

NAA inhibits fruit abscission but the fruit continues to mature at an accelerated rate. The higher the concentration used and the greater the number of applications, the greater the ripening effect. One application of single strength (10 ppm) has little effect on direct ripening. However, it is recommended that apples, particularly McIntosh, not be stored long term (late opening CA or long-term cold) if they have been treated with NAA. Market apples from trees treated a second time with NAA immediately.

## Recommendations for Use of ReTain

ReTain is a plant growth regulator which acts as a stop-drop and serves as a harvest management material by inhibiting the production of ethylene in maturing apples. Applying this material 4 weeks before the anticipated harvest date has shown it to be an effective preharvest drop control agent for apples. ReTain may also delay maturity of apples on the tree, allowing a longer harvest window for a particular variety. Although the ripening process in ReTain-treated fruit is temporarily delayed, treatment with ReTain may result in an increase in soluble solids, colour, fruit size, fruit firmness and a reduction in incidence of water core. Fruit treated with ReTain should be picked at the same internal maturity (based on starch-iodine tests) as untreated fruit. There may be a 7–10 day delay from the beginning of predicted harvest date of untreated fruit for that year to the beginning of the harvest of ReTain-treated fruit.

### Recommended use 4–5 weeks before anticipated harvest

Use one, 333 gram pouch (50 grams a.i.) of ReTain per 0.40 ha (1 acre) plus 0.5–1.0 L Sylgard®309 (organosilicone surfactant) in 1000 L/water. The application must be

made 4 weeks before anticipated harvest, adjusted for any seasonal differences that have advanced or delayed the “normal” harvest date for that year. If this date is elusive, it is better to be early (5 weeks) rather than late (3 weeks). Late applications will not perform well because ethylene production within the plant may have already begun and this is difficult to suppress once initiated. To help determine the beginning of the “normal” harvest period, refer to historical trends for harvest dates for each cultivar in your area.

### **Precautions**

When mixing ReTain with the surfactant, keep agitation to a minimum as Sylgard®309 has a tendency to foam. To minimize foaming, add Sylgard®309 last and when the tank is full. Compatibility and performance data for ReTain with antifoam products are not available. Surfactants other than Sylgard®309 are presently not registered with ReTain for use in Canada. If the rate of ReTain is reduced, maintain the Sylgard rate at a 0.05% – 0.1% v/v ratio.

Discard any unused spray material at the end of each day. Do not use excessively dilute rates or allow run off as this may reduce efficacy and wastes product. Do not tank mix with other products except Dipel or Foray. Combination effects and potential interactions between ReTain and NAA (naphthaleneacetic acid) or Ethephon products have not been

thoroughly evaluated. Use of these products on ReTain-treated blocks may negate or reduce the benefits of ReTain.

Do not overhead irrigate for 8 hours after applying. Do not apply to the point of run off, but wet the tree under slow drying conditions. Spray water pH should be between 6 and 8 for best results. Use tree row volume (TRV) reductions cautiously – test on a few rows or small blocks to gain a level of comfort with this technique. For many orchards using size-controlling rootstocks, 1000 L/water per hectare has been shown to be adequate. Adjust water volumes based on tree size and spacing.

### **Additional considerations**

Spray only trees that are healthy and not under drought, insect, disease or nutritional stress. Royal Gala and Gala strains appear to be more responsive to this product in comparison with McIntosh, for example. As a result, treatments made to Gala strains may delay maturity and colour development relatively more than other cultivars and caution is advised.

For multiple pick cultivars such as Royal Gala, time application 4 weeks from the 2<sup>nd</sup> harvest pick date for best results.

**For best storage performance of ReTain, segregate treated fruit from untreated fruit to reduce exposure to ethylene.**

# 8. Berry Crops

## Berry Crop Nutrition

### Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries are developing. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Providing an optimum environment for strawberry root growth is an important step in obtaining a profitable, perennial planting.

**Careful and detailed planning is important prior to planting.**

### pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH, however some micronutrients become less available as pH increases. This may be a problem when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil Acidity and Liming*, page 18.

### Fertilizer for New Plantings (the planting year)

#### Phosphorus (P)

Work phosphorus into the soil before planting. Soils differ in the amount of phosphorus available to plants. Generally, fields that have been cultivated for a length of time require less phosphorus than recently developed fields. Use soil test results to determine the best rate of phosphorus to apply. Table 8–1, *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, shows soil test values and fertilizer requirements for new strawberry plantings. In the absence of a soil test, select a medium rate from Table 8–1.

**Starter Solutions:** If the transplanter allows, a starter solution could be used at planting. This can assist plant establishment, particularly if the soil is cold, because phosphorus availability is significantly reduced when soil temperatures are low. Use a starter solution high in phosphorus such as 10–52–10, 6–24–6, or 10–24–0. Follow the manufacturer's suggested rate of application.

#### Potassium (K)

Use soil test results to determine the best rate of potassium to apply. In the absence of a soil test, select a medium rate from Table 8–1.

Incorporate potassium into the soil before planting. Side dressing of potassium is not generally recommended.

#### Nitrogen (N)

Nitrogen can be applied with the P and K, or as a side dressing 2–3 weeks after planting. Apply 50 kg of N/ha. See Table 3–8 on page 23, for the nitrogen content of various fertilizers.

Apply an additional 25–35 kg N/ha in mid–August to further invigorate plants as they initiate fruit buds for the following year's crop. Use whatever form of N is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply N when leaves are wet. Urea forms of nitrogen may volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of the urea will prevent this problem.

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease. Adjust nitrogen rates proportionately if manure has been applied. See Table 3–5 on page 21 to determine the adjustments required if manure has been used.

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**TABLE 8-1. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries**

Phosphorus				Potassium			
		Phosphate required kg P <sub>2</sub> O <sub>5</sub> /ha				Potash required kg K <sub>2</sub> O/ha	
Soil Test (ppm P)	Rating	New Plantings	Established Plantings	Soil Test (ppm K)	Rating		
0-3	LOW	140	100	0-15	LOW		130
4-5		130	90	16-30			120
6-7		120	80	31-45			110
8-9		110	70	46-60			100
10-12		100	70	61-80			90
13-15		90	60	81-100			80
16-20	MEDIUM	70	50	101-120	MEDIUM		70
21-25		60	40	121-150			60
26-30		50	30	151-180			40
31-40		40	20				
Above 40	HIGH	0	0	Above 180	HIGH		0

### Fertilizer for Established Plantings

#### Nitrogen (N)

Spring applications of nitrogen are not recommended, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigor resulting in softer fruit and dense foliage canopies. This increases the potential for Botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by a day or two.

Some growers with coarse-textured soils have reported benefits from applying low rates of nitrogen (10-20 kg N/ha) in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

The best time to apply nitrogen in established fields is at renovation. After mowing the foliage, apply 50 kg N/ha. Use whatever form of N is economical. Brush pelleted

forms such as ammonium nitrate off the leaves to prevent burning. Do not apply N when leaves are wet. Urea forms of nitrogen can volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of the urea will prevent this problem.

An additional 25-35 kg N/ha is recommended in mid-August to assist the plant in forming next year's fruit buds. It is important that soils are well irrigated after renovation, throughout the summer and early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

#### Phosphorus (P)

Apply phosphorus at renovation with the nitrogen and potassium. Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils. In the absence of a soil test or leaf analysis, select and apply a medium rate of phosphorus from Table 8-1.

### One Year Before Planting Strawberries and Raspberries

Adjust soil pH and organic matter at least 1 year before planting. Plant a weed-smothering cover crop and incorporate it back into the soil to build up organic matter. Liberally apply well-composted manure (45 tonnes of cattle manure per hectare) and incorporate into the soil the year before planting. For information on manure or other sources of organic matter, consult *Managing Soil Organic Matter*, on page 20.

Test the field soil for phosphorus, potassium, magnesium and pH. Information on soil testing and a list of soil testing laboratories that have been accredited by OMAFRA can be found on page 15 and Appendix A.



**TABLE 8-1. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries**

Phosphorus				Potassium		
		Phosphate required kg P <sub>2</sub> O <sub>5</sub> /ha		Potash required kg K <sub>2</sub> O/ha		
Soil Test (ppm P)	Rating	New Plantings	Established Plantings	Soil Test (ppm K)	Rating	
0-3	LOW	140	100	0-15	LOW	130
4-5		130	90	16-30		120
6-7		120	80	31-45		110
8-9		110	70	46-60		100
10-12		100	70	61-80		90
13-15	MEDIUM	90	60	81-100	MEDIUM	80
16-20		70	50	101-120		70
21-25		60	40	121-150		60
26-30		50	30	151-180		40
31-40		40	20			
Above 40	HIGH	0	0	Above 180	HIGH	0

## Fertilizer for Established Plantings

### Nitrogen (N)

Spring applications of nitrogen are not recommended, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigor resulting in softer fruit and dense foliage canopies. This increases the potential for Botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by a day or two.

Some growers with coarse-textured soils have reported benefits from applying low rates of nitrogen (10-20 kg N/ha) in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

The best time to apply nitrogen in established fields is at renovation. After mowing the foliage, apply 50 kg N/ha. Use whatever form of N is economical. Brush pelleted

forms such as ammonium nitrate off the leaves to prevent burning. Do not apply N when leaves are wet. Urea forms of nitrogen can volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of the urea will prevent this problem.

An additional 25-35 kg N/ha is recommended in mid-August to assist the plant in forming next year's fruit buds. It is important that soils are well irrigated after renovation, throughout the summer and early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

### Phosphorus (P)

Apply phosphorus at renovation with the nitrogen and potassium. Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils. In the absence of a soil test or leaf analysis, select and apply a medium rate of phosphorus from Table 8-1.

## One Year Before Planting Strawberries and Raspberries

Adjust soil pH and organic matter at least 1 year before planting. Plant a weed-smothering cover crop and incorporate it back into the soil to build up organic matter. Liberally apply well-composted manure (45 tonnes of cattle manure per hectare) and incorporate into the soil the year before planting. For information on manure or other sources of organic matter, consult *Managing Soil Organic Matter*, on page 20.

Test the field soil for phosphorus, potassium, magnesium and pH. Information on soil testing and a list of soil testing laboratories that have been accredited by OMAFRA can be found on page 15 and Appendix A.

**Potassium (K)**

Apply potassium at renovation with the nitrogen and phosphorus. Application at this timing allows incorporation. Use soil testing and/or leaf analysis to determine what rate to apply. With no soil test or a leaf analysis, select and apply, at renovation, a medium rate of potassium from Table 8-1. Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

**TABLE 8-2. Recommended Nitrogen (N) Rates For Strawberries**

	Before planting or 2-3 weeks after planting	Renovation (after harvest)	Mid-August
Planting years	50 kg N/ha	—	25-30 kg N/ha
Established plantings	—	50 kg N/ha	25-30 kg N/ha

**Leaf Analysis for Strawberries**

Leaf analysis can be used to assess the nutrient status of strawberry plants and to more accurately determine fertilizer requirements. Take leaf samples by July 1 or August 20 for fruiting and non-fruiting plantings respectively. Collect at least 50 fully expanded, recently matured leaves, with petioles removed. Sample different varieties and plantings separately. See Table 8-3, *Optimum Nutrient Level Range of Strawberry Leaves*, for interpretation of leaf analysis values. For more information refer to OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

**TABLE 8-3. Optimum Nutrient Level Range of Strawberry Leaves\***

Nutrient	Optimum Range
Nitrogen (N)	2.0%-3.0%
Phosphorus (P)	0.20%-0.50%
Potassium (K)	1.5%-2.5%
Calcium (Ca)	0.5%-1.5%
Magnesium (Mg)	0.25%-0.50%
Manganese (Mn)	20-200 ppm
Iron (Fe)	25-200 ppm
Zinc (Zn)	15-100 ppm
Boron (B)	20-60 ppm

\* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before Aug. 20 in non-fruiting fields.

**Raspberries**

Raspberries have a fine, fibrous root system. They prefer a deep, well-drained soil. Raspberry soils should also have good water retaining ability and a high organic matter content, approximately 3%. For more information on organic matter, consult *Managing Soil Organic Matter*, page 20.

**pH Requirements**

Raspberries grow best at a soil pH of 5.5-6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 6-12 months before planting. For more information on lime, consult *Soil Acidity and Liming*, page 18. Micronutrients may become limiting when soil pH is above 7.0

**Fertilizer for Raspberries****Nitrogen (N)**

Recommended nitrogen rates are noted in Table 8-4, *Recommended Nitrogen Rates for Raspberries*. Avoid applying excessive nitrogen. It can reduce the number of berries per cane and lead to lower yields. Sources of nitrogen, nitrogen equivalents, are noted in Table 3-8 on page 23.

For summer and fall-bearing raspberries, nitrogen should be applied in early spring (late March-early April). Late applications may lead to winter injury. For fall bearing raspberries, winter injury is not a concern since canes are removed each spring. However, delayed ripening before the first frost can be a potential problem where nitrogen is applied in excess.

**TABLE 8-4. Recommended Nitrogen Rates for Raspberries**

	kg N/ha/season <sup>1</sup>
planting year	30-40
2 <sup>nd</sup> year	40-60
3 <sup>rd</sup> and following years	45-75

<sup>1</sup> Use the lower rates on non-irrigated crops and heavier soils. Higher rates should be applied to irrigated crops and sandier soils.

**Phosphorus (P) and Potassium (K)**

Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test. In the absence of a soil test, assume a phosphorus and potassium level in the medium range. (See Table 8-1) Apply rates accordingly. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc. Phosphorus must be incorporated prior to planting to correct

phosphorus deficiencies. Phosphorus does not move readily through the soil from the surface application.

If the soil test recommends high rates of potash, use sulphate of potash (0–0–50) or sulphate of potash magnesia (0–0–22). Raspberries are sensitive to high chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0–0–60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 3–8 on page 23.

Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Complete soil sampling every 2–3 years.

## Currants and Gooseberries

Adequate soil preparation before planting currants and gooseberries is essential. The soil should be prepared at least a year before planting so the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil should have a rich supply of organic matter, at least 2–3%, to promote good drainage, aeration and moisture retention. Apply 45 t/ha or 20L/m<sup>2</sup> of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used, but these materials should be well decomposed by planting time. For more information on organic matter consult *Managing Soil Organic Matter* on page 20.

### pH Requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil Acidity And Liming* on page 18. Micronutrients may become limiting when soil pH is above 7.0

### Fertilizer Before Planting

Work phosphorus and potassium fertilizer into the soil in early spring a few days before planting. Nitrogen can be incorporated before planting or banded around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen. If planting takes place in the fall, incorporate required phosphorus before planting, but delay application of nitrogen and potassium until the following spring.

### Nitrogen (N)

Incorporate or band 5 g of actual nitrogen per bush in the planting year.

### Phosphorus (P)

Phosphorus must be incorporated prior to planting to correct phosphorus deficiencies. Phosphorus does not move readily through the soil from the surface application. This makes it difficult to correct a problem after the crop is planted. Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. In the absence of a soil test assume a phosphorus level in the medium range and use the rate shown in Table 8–1 on page 75. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

### Potassium (K)

Test the soil before planting and apply the required amount of potassium according to the soil test results. In the absence of a soil test assume a potassium level in the medium range and use the rate shown in Table 8–1 on page 75. Currants and gooseberries are sensitive to injury from the chloride contained in muriate of potash (0–0–60). Use sulphate of potash or sulphate of potash magnesia.

### Fertilizer in Established Plantings

Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, rates should be reduced to the percentage of area receiving the fertilizer. If the fertilizer is banded, band it 30 cm from the base of the plant.

### Nitrogen (N)

Apply 10 g nitrogen per bush in the year after planting. In subsequent years, apply 20 g per bush.

### Potassium (K)

Apply as according to soil test, or assume a moderate level and apply as indicated in Table 8–1 on page 75.

## Highbush Blueberries

Blueberries perform best on acidic, well-drained soils with a high organic matter content. Before planting blueberries, you must test the soil to determine the soil pH and fertilizer requirements. Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will wick soil moisture away from plant roots, so be sure it is thoroughly moistened before planting. For more information see *Managing Soil Organic Matter* on page 20.



## pH Requirements

Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically using sulphur or peat moss. For this reason, choose your site for blueberry production carefully.

If the soil pH is too high, acidify the soil by incorporating elemental sulphur and/or acidic peat moss prior to planting. Refer to Table 8-5, *Amount of Sulphur Required to Lower Soil pH*. Incorporating acidic peat moss with the soil in the planting hole will also provide essential organic matter. Incorporate sulphur 1 year prior to planting to allow sufficient time for the sulphur to acidify the soil. Check the soil pH annually in the plant row and add sulphur when necessary.

**TABLE 8-5. Amount of Sulphur Required to Lower Soil pH (kg/ha)**

Soil Type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1100	110

Example: the initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8. The soil pH must be lowered by  $6.2 - 4.8 = 1.4$  units. Therefore,  $1.4 \times 750 = 1050$  kg/ha of sulphur is required.

## Fertilizer for Blueberries

### Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N) if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid using the nitrate form of nitrogen on highbush blueberries.

In the spring after planting, apply a total of 12 g of actual nitrogen per bush in a split application. Increase the rate of nitrogen each year until a total of 36–48 g per bush is applied. Apply the nitrogen just prior to bud break, petal fall and early July. Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. On older bushes, apply most of the fertilizer under the outer spread of the branches. See Table 8-6, *Nitrogen Requirements for Highbush Blueberries*.

### Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 8-1 on page 75 for soil test interpretation. A single application of phosphorus at soil preparation time is usually all that is required. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in spring under the outer branches of the bushes as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (22% potash, 11% magnesium) or potassium sulphate (50% potash). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0–0–60).

### Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg/ha is required where a confirmed deficiency exists. Magnesium sulphate (Epsom salts, 9.5% Mg) or sulphate of potash magnesia (21% potash, 11% Mg) can be used for soil application. Since sulphate of potash magnesia contains potash, adjust the rate of application to coincide with potash requirements. For foliar sprays, 1.9 kg Mg/1000 L of water (20 kg magnesium sulphate, Epsom salts) with at least 2000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

### Leaf Analysis

Leaf tissue analysis can be used to assess the nutrient status of the plants and to more accurately determine fertilizer requirements. Take leaf samples in late July from halfway down the new shoot growth of the current season. Collect at least 100 leaves from throughout the area being sampled to adequately represent the area. Sample areas with different soil, plant vigour, fertility programs, etc., separately. See Table 8-7, *Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves*.

**TABLE 8-6. Nitrogen Requirements for Highbush Blueberries**

Plant Age	April 1 – 15	May 15	July 1
	(grams N/plant)		
Newly set	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

**TABLE 8-7. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves**

Element ( )	Acceptable Range
Nitrogen (N)	1.7–2.3%
Phosphorus (P)	0.15–0.40%
Potassium (K)	0.36–0.7%
Calcium (Ca)	0.3–0.8%
Magnesium (Mg)	0.12–0.3%
Manganese (Mn)	150–500 ppm
Iron (Fe)	30–100 ppm
Zinc (Zn)	10–100 ppm
Boron (b)	15–50 ppm

See Appendix A for a list of accredited labs.

## Micronutrients for Berry Crops

Deficiencies of micronutrients or trace elements are not wide spread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem.

### Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency can have an effect on growth and fruiting.

There is currently no accredited soil test for boron in Ontario. Use a foliar analysis to check for boron deficiencies. Where a boron deficiency has been confirmed, soil or foliar applications of boron may improve boron in plant tissues. There are several sources of boron, check the manufacturer's recommended rates and timing of applications.

### Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, you can use soil tests to determine the status of manganese in the soil. A soil manganese index value greater than 8 provides adequate manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate.

Use a spreader sticker with manganese sulphate. Soil applications of manganese are not effective. Consult manufacturer's label for complete information on rates and timing.

### Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only 1 side or 1 branch of the plant is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a foliar analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates<sup>1</sup> have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for rates and timing information.

### Blueberries

Iron (Fe) deficiency is common on blueberries if the soil pH is too high. Lowering the soil pH corrects this problem in most cases, and is the preferred method of control. Foliar applications of iron chelates temporarily correct the deficiency, but annual sprays may be necessary. Consult the manufacturer's labels for details on rates and timing.

### Zinc (Zn)

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to leaf analysis, you can use soil tests to determine the status of zinc in the soil. A soil zinc index value greater than 8 provides adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

**Warning: Do Not Concentrate Nutrient Sprays**

<sup>1</sup> Use chelates recommended for foliar sprays.

# Blueberry Calendar

Read the label and follow all safety precautions.

Do not spray closer than days to harvest interval given in brackets.

A spray volume of 700–1000 L of water per hectare is suggested for mature highbush blueberries.

Always consult the product label for suggested water volumes.

Diseases and Insects	Materials	Amount /ha	Comments
<b>Bud Break &amp; Repeat 10–14 Days Later</b>			
Monilinia	• Funginex 190EC(60 days)	1.70 L	Apply if mummy berry has been a problem.
Mummy berry	• <sup>5</sup> Topas 250 EC (60 days)	500 mL	<sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
<b>Bud Swell</b>			
Leaf tiers	• Decis 5 EC (14 days)	150 mL	Leaf tier larvae cause damage very early in the season. Apply if leaf tier was a problem in the past, at the bud cluster stage as flower buds begin to swell and pink tissue becomes visible.
<b>Green Tip</b>			
Phomopsis stem canker	• <sup>4</sup> Bravo 500 (54 days)	7.20 L	<sup>4</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Alternaria			
Anthracnose fruit rot			
<b>Pink Bud</b>			
Phomopsis stem canker	• <sup>4</sup> Bravo 500 (54 days)	7.20 L	<sup>4</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Alternaria			
Anthracnose fruit rot			
<b>First Bloom</b>			
Do not apply insecticides while blueberries are in bloom. See Bee Poisoning, page 41.			
Botrytis twig and blossom blight	• Captan 50 WP (2 days)	3.25 kg	Fungicide sprays for Botrytis are more important when wet weather occurs. Repeat at 7–10 day intervals through bloom if wet. Ferbam will help control mummy berry. Do not use Ferbam later than mid-bloom.
Fruit rot	or Captan 80 WP (2 days)	2.25 kg	
	or Maestro 75 DF (2 days)	2.40 kg	
	• Ferbam 76 WDG (40 days)	3.75 kg	
<b>Petal Fall</b>			
Cherry fruitworm	• <sup>4</sup> Guthion Solupak (14 days)	1.10 kg	Repeat 10–14 days later. Guthion or APM will also control plum curculio. Malathion will also control aphids. Do not use Guthion or APM or Sniper in backpack or home garden–type sprayers.
Cranberry fruitworm	or <sup>4</sup> APM 50 W (14 days)	1.10 kg	
	or <sup>4</sup> Sniper 50 W (24 days)	2.25 kg	
	• Malathion 25 W (1 day)	2.25 kg	
	• Sevin XLR Plus (2 days)	4.00 L	<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Phomopsis stem canker	• <sup>4</sup> Bravo 500 (54 days)	7.20 L	Bravo may cause fruit injury if applied to green fruit.
Alternaria			<sup>4</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
Anthracnose fruit rot			
<b>Fruit Ripening</b>			
Fruit rot (Botrytis)	• Captan 50 WP (2 days)	3.25 kg	Applications at 7–10 day intervals may be required if blossom blight phase of Botrytis was not controlled.
	or Captan 80 WP (2 days)	2.25 kg	
	or Maestro 75 DF (2 days)	2.40 kg	

Diseases and Insects	Materials	Amount /ha	Comments
Blueberry maggot	• Cygon 480 (highbush)	830 mL	<p>Ontario is considered free from blueberry maggot. Most plantings will not require sprays, however growers should monitor for the presence of this pest.</p> <p>Apply the first spray when first blueberry maggot are trapped or when berries begin to turn blue. This would be about July 5–15, depending on the area and season. Apply a second spray about 5–12 days later, depending on the product. Protection is needed as long as adults are active. APM, Sniper, Imidan and Cygon will provide 10–12 days protection under normal conditions. Residual activity of Sevin and Malathion is much shorter.</p> <p>Cygon: maximum 2 applications per season.</p> <p>Imidan: maximum 2 applications per season. Do not use APM or Sniper in backpack or home garden-type sprayers.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p>
	(15 days) (lowbush)	580 mL	
	• <sup>4</sup> APM 50 W (14 days)	1.10 kg	
	or <sup>4</sup> Sniper 50 W (24 days)	2.25 kg	
	• Imidan 50 WP (15 days)	2.25 kg	
	• Sevin XLR Plus (2 days)	4.00 L	
	• Malathion 25 W (1 day)	2.25 kg	

Visit the berry page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/berry.html>

## Stem Cankers

There are several stem cankers and diseases that affect high-bush blueberries. *Fusicoccum* forms distinct elliptical cankers on the lower half of the stem. *Phomopsis* cankers are less defined than *Fusicoccum*, and appear as flattened and elongated areas on the stem. Both cankers can result in rapid wilting and dying of the blueberry canes.

# Disease Control

## Symptoms

Symptoms are most obvious in mid-summer when bushes are stressed by cropping or drought. Blueberry plants that have been over-fertilized with nitrogen, are growing in poorly drained soils, or have suffered winter injury, are more susceptible to *Phomopsis*. Prune out and burn diseased canes as soon as they appear.

## Blueberry Maggot

The blueberry maggot is a regulated pest in Canada. The Federal *Plant Protection Act* and *Regulations* place movement restrictions on blueberry fruit, plants, soil and containers from areas known to be infested with blueberry maggot. These laws are in place to prevent the spread of this pest from infested areas — Nova Scotia, New Brunswick, Prince Edward Island, Maine, New York, Michigan — to non-infested areas, such as Ontario, Quebec, B.C.

Ontario is presently considered "free" from blueberry maggot. When this pest was discovered in Southern Ontario in 1993, quarantine actions were taken immediately to eradicate blueberry maggot from this site and to prevent its spread. From 1994-97, blueberry maggot was detected at 3 more sites in Elgin, Norfolk and Niagara. Again, strict regulations were placed on these farms to prevent spread to other sites.

Use sticky yellow traps, baited with ammonium acetate to monitor activity of adult blueberry maggots. These traps, also used for apple maggot, are available from a number of suppliers. Place traps by mid-June on the perimeter of commercial fields. If abandoned, or wild blueberries are nearby, place traps just outside of commercial fields. See Appendix D for a list of trap suppliers.

## Regulations for Infested Locations

Blueberry growers in areas where blueberry maggot has been detected (Norfolk, Niagara, Elgin) have a greater risk of infestation in these plantings. If blueberry maggot is detected on your farm you must meet strict federal regulations to prevent further spread of this pest. Your fruit must be certified maggot-free before it can be sold from your

# Insect Control

farm. Certification regulations include extra pesticide applications, and inspection and grading of blueberry fruit before it leaves the farm. Application of insecticides to prevent infestation of blueberry maggot is advised. This is easier than meeting certification requirements after infestation has occurred.

As an Ontario blueberry grower, you need to be aware of the potential for blueberry maggot infestation on your farm. It is not known when or how blueberry maggot arrived in Ontario. It may or may not be present in other parts of the province. You must consider the cost of insecticide application and the potential for loss should maggot be discovered on your farm. Spraying the border of the planting (outer 6-8 rows of blueberries) and other high-risk areas with a suitable insecticide may greatly reduce the risk of infestation. Areas recently planted using planting stock from an infested area are high risk.

**If you buy blueberries for re-sale on your farm, do not throw away the culls and unmarketable berries. Deep burial, below the plough layer, is the best way to dispose of this material.**

## Insecticides for Blueberry Maggot Control

Insecticides for blueberry maggot control are listed on page 81. Apply insecticides with sufficient water to obtain good coverage using an airblast sprayer. A spray volume of 700-1,000 L of water/ha is suggested for mature highbush blueberries. Always consult the product label for recommended water volumes.



**Insecticides are very toxic to bees. Minimize bee exposure by applying insecticides early in the morning or later in the evening when bees are not working. Do not spray blueberry plants in bloom.**

Do not use Cygon on blueberries destined for U.S. markets because there is a zero tolerance for the active ingredient dimethoate on blueberry fruit in the United States.

## White Grubs

White grubs are the larval stage of beetles including June beetle, European chafer and Japanese beetle. These beetles lay their eggs in grassy places. The eggs hatch into larvae, or white grubs, and feed on plant roots. White grubs are C-shaped with a tan or brown head capsule and 6 prominent spiny legs.

White grubs can be a pest of blueberries, especially in light soil types. They are especially common along the Lake Erie and Lake Ontario shoreline. White grubs feed on plant roots, causing blueberry bushes to be stunted. They are often associated with mealy bugs and ants.

There are no insecticides registered for white grub control on blueberries. Do not establish new plantings for 2 years after sod or pasture crops. Keep grassy weeds away from the bushes to make the habitat less favorable for white grubs. Clean cultivation between the rows may also reduce populations over time.

Grass parking lots can serve as a large reservoir for the build-up of grubs. Treat these grass areas like turf or lawns, but do not treat inside the planting. If 5 grubs per 1/10th of a square metre (1 ft<sup>2</sup>) are found, treat with insecticide. There are 4 insecticides registered for use on grubs in turf: chlorpyrifos; diazinon; carbaryl and imidacloprid. Apply chlorpyrifos, diazinon and carbaryl between mid-July to mid-Sept. when eggs hatch and larvae begin to feed. Apply these insecticides according to label directions when soil is moist and grubs are feeding near the surface. Imidacloprid is registered for use on European chafer and Japanese beetle grubs only. It can only be applied during grub egg laying

from June 1<sup>st</sup> to August 1<sup>st</sup>. Immediately after applying the insecticides thoroughly water to allow the insecticide to come in contact with grubs in the root zone just below the thatch (or grass mat layer). For more information on white grubs refer to OMAFRA Factsheet *Grubs in Lawns*, Order No. 97-023.

## Pheromone Traps for Monitoring Cranberry Fruitworm

Pheromones can be used to monitor for cranberry fruitworm. Most growers who have used pheromones to determine the timing of cranberry fruitworm sprays have been able to reduce the number of insecticides applied for this pest.

The pheromone for cranberry fruitworm is species specific and will not attract cherry fruitworm. Cranberry fruitworm is the major pest in most areas. To distinguish between cranberry and cherry fruitworm, examine the injury they cause. Cranberry fruitworm ties several berries together and frass is present in the tunnels and webbing. Cherry fruitworm feeds on single berries, and frass is only present inside the berry. Use pheromone with Phercon IC traps. Set traps out around mid-bloom. Use 3 traps for 4 ha (10 acres). Hang traps from the outside branches but not above the bush. Check traps twice weekly and record the number of moths trapped on a chart. Insecticides for cranberry fruitworm can be delayed until 5–10 days after peak catch. A second insecticide is required only if trap catches remain high for an extended period of time.

Pheromone for cranberry fruitworm can be purchased from several suppliers, including Great Lakes IPM and Plant Products Co. Ltd. See Appendix D for a list of trap and pheromone suppliers.

## Bird Control

Birds are often the biggest pest problems in a blueberry planting. For information on bird control see *Bird Damage and its Prevention in Fruit Crops*, page 31. Also see OMAFRA Factsheet *Bird Control on Grape and Tender Fruit Farms*, Order No. 98-035.

# Currant & Gooseberry Calendar

Read the label and follow all safety precautions  
Do not spray closer than days to harvest interval given in brackets.  
For dilute spraying, use 2000 L of water per hectare.

Diseases and Insects	Materials	Amount per 1000L	Amount per Hectare	Comments
<b>Just Before Blossoms Open</b>				
Do not apply insecticides while currants or gooseberries are in-bloom. See Bee Poisoning page 41				
Leaf spot	• Ferbam 76 WDG (14 days)	3.35 kg	6.75 kg	Use Ferbam on currants only.
Powdery mildew	• Sulphur 92 WP (1 day)	2.50 kg	5.00 kg	Gooseberries only. Do not use on "sulphur—shy" American varieties.
Currant sawfly	• Diazinon 50 W	1.00 kg	2.00 kg	Do not apply Diazinon after bloom. Malathion is not registered for sawfly control.
Blister aphid	or Diazinon 500 E	1.00 L	2.00 L	
	• Malathion 25 W (3 days)	2.50 kg	5.00 kg	
<b>Post-Bloom as soon as bloom is complete</b>				
Leaf spot	Add one of fungicides listed above.			
Powdery mildew	Same as for mildew above.			Repeat weekly if warm and humid conditions persist.
Currant fruitworm	• Malathion 25 W (3 days)	2.5 kg	5.00 kg	Where this pest was a problem, apply a second time in 10 days. For best results apply when the temperature is above 20°C.
<b>10 Days After Post-Bloom Spray</b>				
Leaf spot	Same as for leaf spot above.			Spray red and white currants immediately after fruit is picked.
Currant fruitworm	• Malathion 25 W (3 days)	2.5 kg	5.00 kg	For best results apply when temperature is above 20°C.
<b>Post-Harvest</b>				
Leaf spot	Same as leaf spot above.			
Aphids, mites and leafhoppers	• Malathion 25 W (3 days)	2.50 kg	5.00 kg	

Visit the berry page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/berry.html>

# Disease Control

## Powdery Mildew

This disease is common on currants and gooseberries. The fungus causes a powdery white growth on the surface of the leaves, shoots and fruits. Infected plants are often stunted and defoliated. Powdery mildew is a limiting factor in black currant production where susceptible varieties are grown.

There are no fungicides registered for control of mildew on currants at this time. Choose resistant varieties. (See Table 8-8, *Disease Ratings on Selected Currant and Gooseberry Varieties*.)

## White Pine Blister Rust

White pine blister has a complex life cycle. The rust fungus spends part of its life on wild and cultivated species of gooseberry and currant, and part on white pine (5-needled pine).

### Symptoms

Symptoms on gooseberry and currant appear as small slightly raised yellow-orange spots, known as uredia, usually arranged in a circle on the underside of infected leaves. The uredia produce masses of yellow-orange spores that can re-infect currant leaves throughout most of the growing season. Later in the season, brownish hair-like structures, known as telia, develop in the uredia lesions. During

cool, wet nights, the hair-like telia produce a small spore that travels not much further than a mile and only infects white pine. In the spring infected white pine stems and branches produce spindle shaped cankers surrounded by a narrow margin of yellow-orange bark. The cankers develop small, dark brown blisters that ooze spores. The cankers expand producing white sack-like blisters called aecia from which the disease gets its name. The blisters eventually rupture and release masses of orange-yellow spores. These spores can travel hundreds of miles and only infect currants and gooseberries.

### Control

White pine blister rust is more serious on white pines than it is on currants. Although the rust disease can defoliate currants, it does not appear to significantly affect yield. However, white pine trees can be killed by this disease. Because white pine blister rust has caused severe economic losses in the forestry industry, currant production is restricted in many parts of the USA. In Ontario, there is no legislation regulating currant production, but black currants, even moderately resistant varieties, should not be grown within a mile of white pines. Destroying wild gooseberry and currant plants within a mile radius between cultivated currants or gooseberries and near by white pines may help reduce the impact of the disease in a particular area.

TABLE 8-8. Disease Ratings on Selected Currant and Gooseberry Varieties\*

Type	Variety	Mildew Resistance	Rust Resistance <sup>1</sup>
Black currant	Ben Alder	Resistant	Very susceptible
Black currant	Ben Connan	Resistant	Moderately resistant
Black currant	Ben Sarek	Resistant	Moderately resistant
Black currant	Titania	Resistant	Resistant
Red currant	Red Lake	Susceptible	Moderately resistant
Red currant	Red Start	Susceptible	Moderately resistant
Red currant	Rovada	Resistant	Moderately resistant
Red currant	Jonkheer van Tets	Resistant	Resistant
Gooseberry	Invicta	Resistant	Moderately resistant
Gooseberry	Hinnonmaki Red	Resistant	Moderately resistant

\* not all varieties proven acceptable for Ontario conditions

<sup>1</sup> **Resistant:** Does not show symptoms of rust

**Moderately resistant:** Shows symptoms at low frequency, yield not affected

**Susceptible:** Noticeable levels of rust infection, not affecting yield

**Very susceptible:** Severe infection, affecting yield

Source: Adam Dale, University of Guelph, Ontario and Dick McGinnis, McGinnis Berry Crops, B.C., personal communication, 1999

# Raspberry & Blackberry Calendar

Read the label and follow all safety precautions.  
Do not spray closer than days to harvest interval given in brackets.  
Use at least 2000 L of water per hectare, unless stated otherwise.

Diseases and Insects	Materials	Amount per Hectare	Amount per 1000 L	Comments
<b>Delayed Dormant to Green Tip</b>				
Anthraxnose and Spur blight	• Lime sulphur	52.5 L	35 L	<b>Do not use lime sulphur later than 1/4 inch green due to phytotoxicity.</b> Use 1500 L of water/ha. This is the primary component of a good control program.
<b>Prebloom (until blossoms open)</b>				
Anthraxnose and Spur blight	• Ferbam 76 WDG	4.50 kg	2.25 kg	Apply when canes are 25–30 cm tall and again just before first bloom.
Powdery mildew	• Benlate 50 WP plus	1.10 kg	550 g	In problem areas, spray when mildew is first observed. Repeat in 7–10 days. Apply no more than 2 sprays, to prevent resistance to these products.
	• Captan 50 WP (2 days)	4.50 kg	2.25 kg	
	• Senator 70 WP (1 day)	1.10 kg	500 g	
Raspberry sawfly	• Diazinon 50 W	2.00 kg	1.00 kg	Diazinon will also provide some aphid and raspberry fruitworm control. <b>Do not apply after first blossoms open.</b>
Raspberry fruitworm	• Malathion 25 W (1 day)	9.00 kg	4.50 kg	Repeat in 7–10 days where there has been a history of injury.
Spring feeding caterpillars and leafrollers	• <sup>4</sup> Guthion Solupak (7 days)	1.75 kg	875 g	Foray is only recommended for the control of leafrollers. Frequent monitoring of leafroller life stages is recommended. Foray is most effective on early instars. Two to 3 applications may be required to cover the extended emergence of larvae. For best results apply early evening or on cloudy days. Do not use Guthion or APM in knapsack or other home garden type sprayers.
	or <sup>4</sup> APM 50 W (3 days)	1.75 kg	875 g	
	• Foray 48 BA (1 day)	2.80 L	1.40 L	

<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.

## Bloom

Do not apply insecticides while raspberries and blackberries are in bloom.

See Bee Poisoning page 41

Fruit rots on raspberries	• Rovral 50 WP (1 day)	2.00 kg	1.00 kg	Repeat every 7 days until the end of bloom if wet.
	• Captan 50 WP(2 days)	4.00 kg	2.00 kg	
	or Captan 80 WP(2 days)	2.50 kg	1.25 kg	(Maestro 75 DF at 2.4 kg/ha for blackberry)
	or Maestro 75 DF(2 days)	2.70 kg	1.35 kg	
	• Benlate 50 WP plus	1.10 kg	550 g	
	Captan 50 WP(2 days)	4.50 kg	2.25 kg	

## Green Fruit

Leafroller	• Foray 48 BA (1 day)	2.80 L	1.40 L	Leafroller populations tend to be more attracted to BC varieties such as Chilliwack, Chilcotin, Tulameen and Comox than other varieties.
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## Postharvest (as soon as crop harvest is complete)

Leathoppers	• <sup>4</sup> Guthion Solupak (7 days)	1.10 kg	550 g	Do not use Guthion or Sniper in knapsack or other home garden type sprayers. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
	or <sup>4</sup> Sniper 50 W (7 days)	1.10 kg	550 g	
	• Malathion 25 W (1 day)	9.00 kg	4.50 kg	
Powdery mildew	• Benlate 50 WP (2 days)	1.10 kg	550 g	Repeat every 14 days if disease becomes evident on new growth.
	• Senator 70 WP (1 day)	1.10 kg	550 g	
Anthraxnose and Spur blight	• Ferbam 76 WDG	4.50 kg	2.25 kg	Remove and destroy old canes immediately after harvest.

Diseases and Insects	Materials	Amount per Hectare	Amount per 1000 L	Comments
<b>Special Sprays</b>				
Two-spotted spider mite	• Apollo SC (15 days)	500 mL	250 mL	Good weed control and removal of fruiting canes immediately after harvest will also reduce mite problems. Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Apply no more than once/year. Thorough spray coverage of leaf undersides is required. Use high water volumes. Only apply Apollo once every 2 or more years.
Raspberry crown borer				If more than 5% of the crowns are infested, apply this spray to lower portions of canes and to soil beneath the plants to the crown area. Infested plantings should be treated for at least 2 years in a row.
	• Diazinon 500 E		1 L/1000 L water	Apply diazinon in 4000–5000 L of water/ha. Apply in spring to control young larvae before they tunnel into crowns.
	• Diazinon 50 W		1 kg/1000 L water	Apply when new growth is about 10 cm above ground. Do not apply after bloom.
	• Guthion Solupak	2.25 kg	1.12 kg	Apply Guthion in early spring or in mid Sept.–mid Oct., to control eggs and young larvae. Apply in 1600 L of water /ha. *Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Phytophthora root rot	• Ridomil Gold 480 EC			Apply 37 mL of Ridomil Gold per 100 m of row, to the soil surface in a 1 m band centred over the row. Use at least 2,500 L of water /ha.  In new plantings, apply as a post-planting soil drench and again in the fall in mid to late Oct. (no later than Oct. 31).  In established plantings, apply Ridomil Gold in the fall only. Do not apply in spring to established plantings.  Aliette WDG is best used as a preventive treatment. Apply no more than 4 applications/yr: 2 in the spring and 2 in the fall.
	• Aliette WDG	5.50 kg	2.75 kg	<b>Spring application:</b> Apply the first spray of Aliette after bud break at 7 cm of new growth and then again 3–4 weeks later. Do not apply within 60 days of harvest.  <b>Fall application:</b> Apply when conditions favour disease development (high soil moisture and cool temperatures) and then repeat if necessary 3–4 weeks later. The last fall application should be made at least 30 days before leaf drop.  <b>Precautions:</b> Crop phytotoxicity is possible when Aliette is mixed with copper. Care should be taken when mixing Aliette with nitrogen-based foliar fertilizer. Incompatibility with some suspension concentrate formulations can occur.

Visit the berry page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/berry.html>



# Disease Control

## Cultural Practices for the Control of Root, Cane and Fruit Rot Diseases

- Plant raspberries on well-drained sites with good air circulation. Plant new raspberries on 25–30 cm (10–12 in.) raised beds to improve drainage and reduce the potential of *Phytophthora* root rot developing. This technique is especially important on sites with clay loams, fluctuating water tables, or where susceptible varieties such as Canby, Taylor, Titan, Lauren and Ruby are being considered.
- Space rows at least 2.5 m apart. Limit width of plants within rows to 30–45 cm. Excess canes in the row should be thinned out.
- Immediately after harvest is finished, prune out fruiting canes and weak growth.
- Keep rows free from weeds.
- In spring, prune out and burn canes or portions of canes showing swelling, scars and cracks.

## Viruses

Virus diseases, such as raspberry mosaic virus and raspberry leaf curl, are the main causes of low yields and poor quality fruit. Aphids are the main vectors that spread these viruses from infected to healthy plantings. Leaves of virus-infected plants may not always show leaf curling and puckering symptoms, or the yellow mottled discoloration known as mosaic. Virus infected plants often produce small crumbly berries and low yields.

Symptoms of virus diseases can be confused with similar symptoms from other causes. For example, herbicide injury, poor crop nutrition, root rots, or drought may cause poor vigor and yellowing or curled leaves. Poor pollination, plant bug injury, or a crop nutrition problem may also cause crumbly berries.

Some virus diseases can be diagnosed by the Pest Diagnostic Clinic at the University of Guelph (see Appendix E). Diagnosis of virus diseases is difficult, and should be considered only when other potential causes of the problems have been ruled out.

The following steps will help minimize the spread of viruses.

- Use virus-tested, disease free planting stock from an accredited plant propagation program.
- Destroy all nearby wild raspberries and blackberries.
- Set new plantings at least 16 m from older plantings. Do not plant red raspberries close to purple and black raspberries.
- Rogue out and completely destroy all virus-infected plants as soon as symptoms of mosaic or leaf curl appear.

## Crown Gall and Cane Gall

Crown gall can be caused by 2 related soil-borne bacteria. It infects raspberry roots, crowns and lower stems of fruiting canes through wounds. The bacteria induce the plant tissue to grow abnormally, resulting in the production of spongy wart-like galls on infected crowns and roots. The galls eventually become hard and woody as they age. Raspberry plants with numerous galls often appear stunted and may become weak. The galls disintegrate over the winter and release the disease-causing bacteria into the soil. New galls often form in the area of the old galls the following spring.

Do not plant canes infected with crown gall. Purchase disease free plants from an accredited nursery. Do not plant new canes in infested soil. Avoid injury to crown and roots. Maintain good soil fertility.

## Verticillium Wilt (bluestem)

Verticillium wilt can be caused by 2 related soil-borne fungi. The fungi infect plants through roots, eventually colonizing and plugging the vascular system. Infected plants may wilt and dry up. Frequently, only canes on one side of infected plant appear wilted. A bluish discoloration on the stem is characteristic of this disease. Black raspberries are much more susceptible than red raspberries to *Verticillium*.

To control *Verticillium*, do not plant raspberries following tomatoes, potatoes, eggplants, or peppers, because these crops are good hosts for the wilt causing pathogens.

- *Red raspberries*: Cut out and destroy infected canes.
- *Black and purple raspberries*: Dig out and destroy infected plants.

See Table 4-1 on page 29 for pre-planting soil fumigation treatment.

## Orange Rust of Blackberry

This disease only occurs on blackberries, black raspberries and purple raspberries. Infected plants produce weak, spindly shoot growth with yellow misshapen leaves in the spring. Leaves on these shoots develop bright orange pustules on the lower surface. Unlike most fungus diseases, orange rust is systemic in the plant. To prevent the disease from spreading, dig out and destroy infected plants early in the spring before pustules break open.

## Fire Blight

Fire blight on raspberry has not been a common problem in Ontario. However, it has caused considerable damage to the variety K81-6 in some infected fields and has also been observed occasionally on Boyne. The disease is caused by bacteria, similar, but not identical to the bacteria that cause fire blight on apples and pears.

Primocane tips and laterals of infected raspberry canes appear wilted, black and frequently curve down in the form of a shepherd's-crook. Infected fruit or flower clusters appear water-soaked and eventually turn black. Droplets of white or amber bacterial ooze may be excreted from the lesions of infected tissue. Infected berries become hard, dry and brown, and remain attached to the pedicel.

To avoid fire blight, do not plant susceptible varieties such as Boyne and K81-6.

Avoid overhead irrigation on susceptible varieties, because this practice can cause wounding of tissue, favoring infection, and spread the bacteria to healthy plants

Prune out infected canes and remove from the planting as soon as observed. Remove infected canes on a dry day to prevent the bacteria from spreading to other canes. Cut the

canes out as close to the ground as possible and destroy them. If possible avoid carrying the exposed disease canes through the field.

Insects with piercing sucking mouthparts, such as tarnished plant bugs, can spread the fire blight bacteria and encourage infection. Insects that pierce plant tissue, such as earwigs, can also spread the disease. Ants are efficient at spreading the bacteria to healthy blossoms. Monitor for these insects and control them if necessary.

**TABLE 8-9. Relative Resistance of Raspberry Varieties to Cane Infection by Fire Blight<sup>1</sup>**

Resistant	Partially resistant	Susceptible	Highly susceptible
Heritage	Ruby	Kilarney	Carnival
Nova	Avon	Comox	Boyne
Royalty	Polana	Taylor	Reveille
	K81-6*	Algonquin	Latham
	Caroline	Canby	Encore

<sup>1</sup> based on laboratory tests

\* K81-6 is very susceptible to fire blight in the field.

Source: G. Braun, A. Jamieson and P. Hildebrand, Agriculture and Agri-Food Canada, Kentville, N.S. 1999

## Phytophthora Root Rot

Phytophthora root rot is caused by a soil-borne fungus that is very persistent. The fungus produces spores that swim in water and infect roots and crowns when soil conditions are very wet. The disease frequently appears on plants grown on heavy, compacted or poorly drained soil. Infected plants appear weak with few, wilted primocanes and are frequently found in patches. Confirm diagnosis by digging up plants and scraping away the outer tissue of diseased crowns. Phytophthora infections cause a reddish discoloration just beneath the bark of the infected crown.

Phytophthora root rot can be partially managed by the use of fungicides, but crop management practices are more important than fungicides for preventing and controlling this disease. Select fields with excellent drainage and avoiding low-lying areas. Consider the use of raised beds to keep the water table below the plant roots. Some varieties of raspberries are very susceptible to Phytophthora, while others are fairly resistant. (See Table 8-10, *Field Resistance of Red Raspberry Varieties to Phytophthora Root Rot*.) Avoid growing susceptible varieties, especially in heavier soil types, or on soils prone to flooding.

**TABLE 8-10. Field Resistance of Red Raspberry Varieties to Phytophthora Root Rot**

Partially Resistant	Susceptible	Very susceptible
Latham Killarney Boyne	Heritage Taylor Newburgh Royalty	Titan Canby Ruby Lauren*

Source: W. Wilcox and M. Pritts, Cornell University, and \* field observation

## Cane Blight

Cane blight is one of the most serious raspberry cane diseases in Ontario. The pathogen enters primocanes through wounds and spreads up and down the vascular tissue, causing the cane to become brittle and weak. Diseased canes may die during the winter, or they may leaf out erratically in the spring. Infected canes that appear healthy may collapse or break above the point of injury and infection just as harvest begins. Symptoms of cane blight look similar to

those caused by cane and crown borers. Cane blight can be diagnosed by scraping back the bark of infected canes to expose the vascular tissue. The diseased vascular tissue beneath the bark will appear distinctly brown instead of green.

Preventing injury to primocanes prevents cane blight. Canes may be wounded by rubbing against trellis wires, by machine harvesters, or by summer pruning. The pathogen frequently enters new primocanes through wounds caused by rubbing against old stubs pruned too high above the ground. Cane blight can be reduced by carefully pruning out old fruiting canes close to ground level after harvest. Avoid pruning or tipping when plants are wet or just before a rain.

**Cane blight is one of the most serious raspberry cane diseases in Ontario.**

## Insect Control

### Raspberry Cane Borer

This pest is a long-horned beetle that is active in June and July. It lays eggs in the tips of raspberry primocanes. Canes are girdled with 2 zipper-like rings 15 mm apart. The tip wilts and the larva bores down into the cane where it hibernates. There are no insecticides labeled for control of this pest. Examine canes frequently in June and July for injury. Cut off wilted tips below lower ring as they appear and burn them.

### Red-Necked Cane Borer

This pest is seen occasionally in raspberries in Ontario. It can cause severe damage. The adult beetle is a flat-headed borer that emerges from fruiting canes in late spring or early summer. Eggs are laid on the lower half of the primocanes. Larvae tunnel in a spiral fashion around the cane. The first few spirals under the bark result in a swelling or gall. The larvae continue to tunnel up or down the cane in the pith. Infested canes may wilt or dry up, and often break off at the gall.

There are no insecticides registered for control of this pest. Prune out and remove infested canes before spring.

### Sap Beetles

Sap beetles, also called picnic beetles, are 6 mm long, black with cream markings. They are attracted to ripe fruit, and infest raspberries in the field and after harvest. No chemical sprays give effective control of sap beetles. The pest can be managed by harvesting on a regular basis, and removing damaged and diseased fruit as well as healthy fruit. Bury compost and trash piles or locate them at a different site. Never put boxes of berries on the ground. Remove harvested fruit to a screened building or shelter immediately after picking.

Baits may be used on a small scale to trap beetles. Apple cider vinegar or a mixture of yeast, sugar and water combined with a few drops of liquid detergent will drown the beetles. Commercially prepared bait containing the insecticide carbaryl is available.

## Establishment Year — New Plantings

### CULTURAL CONTROL

Incorporate these techniques into your farming system in order to suppress pest populations.

Diseases & Insects	Cultural Practice	Comments
<b>Between plantings</b>		
White grub Wireworm	Crop rotation	Consider cultivated row crops such as snap beans, white beans, cabbage, broccoli, brussels sprouts and cauliflower. Avoid preferred hosts such as corn, grasses, cereal species and potato.
Root-lesion nematode White grub Root weevil Wireworms Annual and perennial weeds Two-spotted spider mite	Summer fallowing	Cultivate to 10 cm (4 in.) frequently enough to kill young weeds and discourage weed growth. Intervals between cultivations will vary according to rainfall and weed pressure. Avoid this practice on sloping land prone to erosion. Sow oats or spring wheat in Sept. as a cover crop to minimize soil erosion by wind and water. Do not use cereal rye, as this encourages nematodes. For more details on preplant weed control, consult Chapter 12, <i>Weed Management for Fruit Crops</i> . Refer to the "Site Preparation" and "Special Methods of Weed Control" sections.
<b>Before planting</b>		
Verticillium Red stele Leather rot Black root rot	Site selection Crop rotation	Select a site with good soil drainage. Avoid heavy poorly drained soils. Avoid sites with a history of red stele and Verticillium. Specifically for Verticillium, avoid susceptible crops preceding strawberry such as potato, tomato, peppers, eggplant and alfalfa.
Botrytis fruit rot Leaf scorch Leaf spot Leaf blight	Site selection	Select a planting site with good air drainage. Expose plants to direct sunlight and plant rows parallel with the direction of the prevailing winds to promote fast drying of foliage and fruit.
Root weevil Cyclamen mite	Isolation	Isolate new plantings from older infested plantings to provide a physical barrier to reduce land migration of these pests.
Red stele Verticillium	Cultivar selection	The following varieties have some degree of resistance to the red stele fungus ( <i>Phytophthora fragariae</i> ), Annapolis, Cavendish, Sparkle, Tribute, Tristar, Vantage and Veestar. See Table 8-12, <i>Strawberry Variety Disease Ratings</i> , on page 98 for more information. Verticillium resistant varieties include: Annapolis, Governor Simcoe, Settler, Tribute, Tristar, Vantage and Veestar. Use only plants which have been grown under the guidelines of an accredited plant propagation program.

## Establishment Year — New Plantings

### CHEMICAL CONTROL

Read the label and follow all safety precautions.  
Do not spray closer than days to harvest interval given in brackets.  
Use enough water when spraying to thoroughly wet plants.

Diseases and Insects	Materials	Amount/ha	Comments
Use only plants grown under the guidelines of an accredited plant propagation program			
<b>After Planting</b>			
Cutworms	• Sevin XLR Plus	2.50 kg	Sprays of Sevin will control above ground cutworms only.
<b>Early June</b>			
Strawberry leafroller	• <sup>4</sup> Guthion Solupak or <sup>4</sup> APM 50 W or <sup>4</sup> Sniper 50 W • Malathion 25 W	1.10 kg 1.10 kg 1.10 kg 4.25 kg	<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>One Month After Planting and again ONCE or TWICE at 2 Week Intervals</b>			
Leaf blight	• Copper 53 W	3.80 kg	Spray susceptible varieties such as Bounty, Kent, Veestar, Tristar, Micmac and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays see <i>Use of Copper Products on Fruit Crops</i> , page 34. Equal may injure plants under cold weather conditions. Alternate between copper and Equal to reduce the development of resistance.
Leaf scorch	• Equal 65 WP	1.75 kg	
Leaf spot			
<b>July to mid-Aug.</b>			
Potato leafhopper	• <sup>4</sup> Guthion Solupak or <sup>4</sup> APM 50 W or <sup>4</sup> Sniper 50 W • Malathion 25 W	1.10 kg 1.10 kg 1.10 kg 4.25 kg	Repeated applications may be necessary for leafhopper control.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>Fall</b>			
Red stele			To reduce the chance of resistance developing, this application is only necessary where red stele has been observed and confirmed. Apply as a broadcast application in sufficient water (2500 L/ha) to ensure movement into the root zone.
	• Ridomil Gold 480 EC	1 L	Make 1 Ridomil Gold application in early Sept., and a second treatment in late Oct., but not later than Oct. 31.
	• Aliette WDG	5.60 kg	With Aliette, make a maximum of 4 applications per season, 2 in the spring and 2 in the fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Make fall applications when soil conditions favour disease development (e.g., high soil moisture and cool temperatures).



## Bearing Years

### CULTURAL CONTROL

Incorporate these techniques into your farming system in order to suppress pest populations.

Diseases & Insects	Cultural Practice	Comments
<b>Late April to Early May</b>		
Plant bugs Spittle bug Two-spotted spider mite Botrytis fruit rot Leather rot	Weed control	Broadleaf weeds provide alternate hosts and encourage the subsequent build up of resident plant bug and two-spotted spider mite populations. Grassy fence rows or volunteer grass in the planting provide alternate hosts and subsequent build up of resident spittle bug populations. Weeds keep relative humidity high and prolong leaf wetness, thus encouraging fruit rots.
<b>Mid to Late May</b>		
Leather rot	Straw mulch	Apply a straw mulch thick enough to prevent soil from splashing onto berries at petal fall and prior to significant berry formation.
Botrytis fruit rot Leather rot Black root rot	Fertilization	Avoid excessive fertilization which can encourage too much foliar growth, creating a dense, humid canopy.
<b>Preharvest to Harvest</b>		
Botrytis fruit rot Leather rot Black root rot Verticillium Red stele	Irrigation scheduling	Adjust timing of irrigation for evaporative cooling and drought relief to mid-day (10:00 am – 3:00 pm) with short periods of water application to allow foliage and fruit to dry out before nightfall. Do not apply too much water at one time. Avoid creating puddles.
<b>Renovation (early July)</b>		
Two-spotted spider mite Powdery mildew	Mowing	Mowing off of strawberry leaves eliminates the food source for these pests, thus reducing population numbers.
Botrytis fruit rot Leather rot	Narrowing rows	Narrowing the width of the matted row to 30 cm (12 in.) decreases plant density and encourages aeration and quick drying of the crop canopy. Incorporating plant crop residues into the soil and rototilling helps destroy the main source of Botrytis. If runnerling is too vigorous, rows can be narrowed again in Oct. using a coultter.
<b>Renovation</b>		
Black root rot	Subsoiling	Subsoiling in late July or Aug. can reduce compaction and improve the drainage of the soil.

### CHEMICAL CONTROL

Read the label and follow all safety precautions.

Do not spray closer than days to harvest interval given in brackets.

Cymbush, Ripcord and Decis are pyrethroid insecticides. Over-use of these products may encourage pest resistance or may induce mite problems. Repeated applications are discouraged.

Diseases and Insects	Materials	Amount/ha	Comments
<b>When New Growth Appears</b>			
Botrytis gray mould	• <sup>4</sup> Bravo 500 (30 days)	3.50 L	Bravo helps to control Botrytis by reducing disease inoculum and by preventing infection of dying leaves. Repeat application in 10 days. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>When Flower Buds Are Visible in The Crown</b>			
Leaf blight	• Copper 53 W (1 day)	3.80 kg	Spray susceptible cultivars such as Bounty, Kent, Veestar, Micmac, Tristar and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays, see <i>Use of Copper Products on Fruit Crops</i> , page 34. Equal may injure plants under cold weather conditions. Alternate between copper and Equal to reduce the development of resistance.
Leaf scorch	• Equal 65 WP (7 days)	1.75 kg	
Leaf spot			

Diseases and Insects	Materials	Amount/ha	Comments
<b>As Flower Buds Extend From Crown</b>			
Strawberry clipper weevil	• <sup>4</sup> Furadan 480 F	1.10 L	Check edges of fields for clipped buds. Apply insecticide when first injury is detected. A second application may be required if new injury is detected 7 days after the first spray. Do not use Furadan later than bloom because of its toxicity to pollinating and beneficial insects. Use Furadan only once during the season. Note: Furadan can cause extensive burning of sepals surrounding fruit on certain varieties (e.g. Annapolis, and Cavendish). <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
	• Cymbush 250 EC (7 days)	280 mL	
	or Ripcord 400 EC (7 days)	175 mL	
	• <sup>3</sup> Matador 120 EC (7 days)	104 mL	

### First Bloom

Insecticides are very toxic to bees.  
Do not spray when bees are working.  
Spray in the evening. See Bee Poisoning, page 41.

Plant bugs	• Cygon 480 EC	2.75 L	Cymbush, Ripcord, Matador or Decis also control clipper weevil. Thiodan, Cymbush, Ripcord, Matador or Decis also control spittlebug.
	• Cymbush 250 EC (7 days)	400 mL	
	or Ripcord 400 EC (7 days)	250 mL	<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	• Decis 5 EC (14 days)	200 mL	
	• <sup>3</sup> Matador 120 EC (7 days)	104 mL	
	• Thiodan 50 WP or Endosulfan 50 W (7 days)	4.00 kg	
Botrytis gray mould	• Rovral 50 WP (1 day)	2.00 kg	Keep all flower parts protected with fungicide during bloom for good control of Botrytis. Typically 2–3 sprays during bloom will give good control. Shorten intervals to 3–5 days if weather is wet. Use Rovral or Ronilan when disease pressure is high. Since Rovral and Ronilan are in the same chemical family, do not use them in consecutive sprays or more than 2 sprays/season. Alternate with other fungicides. See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> on page 26. <sup>1</sup> Minimum period for reentry is 4 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Folpan 50 W (1 day)	2.25 kg	
	• Captan 50 WP (2 days)	6.75 kg	
	or Captan 80 WP (2 days)	4.25 kg	
	or Maestro 75 DF (2 days)	4.00 kg	
	• <sup>5</sup> Ronilan 50 DF (3 days)	2.00 kg	
	• <sup>1</sup> Elevate 50 WDG (1 day)	1.70 kg	

### 7 to 10 Days After First Bloom

Plant bugs	• Cymbush 250 EC (7 days)	400 mL	<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
	or Ripcord 400 EC (7 days)	250 mL	
	• Decis 5 EC (14 days)	200 mL	
	• <sup>3</sup> Matador 120 EC (7 days)	104 mL	
	• Thiodan 50 WP	4.00 kg	
	or Endosulfan 50 W (7 days)	4.00 kg	
Botrytis gray mould	• Rovral 50 WP (1 day)	2.00 kg	Shorten intervals to 3–5 days if wet weather persists. Use Rovral or Ronilan when disease pressure is high. <sup>1</sup> Minimum period for reentry is 4 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Folpan 50 W (1 day)	2.25 kg	
	• Captan 50 WP (2 days)	6.75 kg	
	or Captan 80 WP (2 days)	4.25 kg	
	or Maestro 75 DF (2 days)	4.00 kg	
	• <sup>5</sup> Ronilan 50 DF (3 days)	2.00 kg	
	• <sup>1</sup> Elevate 50 WDG (1 day)	1.70 kg	

### Preharvest

Botrytis gray mould	• Rovral 50 WP (1 day)	2.00 kg	If irrigation is necessary, water early in the day to allow plants to dry off before nightfall. <sup>1</sup> Minimum period for reentry is 4 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Folpan 50 W (1 day)	2.25 kg	
	• Captan 50 WP (2 days)	6.75 kg	
	or Captan 80 WP (2 days)	4.25 kg	
	or Maestro 75 DF (2 days)	4.00 kg	
	• <sup>5</sup> Ronilan 50 DF (3 days)	2.00 kg	
	• <sup>1</sup> Elevate 50 WDG (1 day)	1.70 kg	

Diseases and Insects	Materials	Amount/ha	Comments
<b>Fall</b>			
Botrytis gray mould	• <sup>4</sup> Bravo 500	3.50 L	Bravo helps to control Botrytis by reducing disease inoculum. Apply in late Oct. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>Special Sprays</b>			
Some insects and diseases are sporadic. These pests may require a control infrequently, for example 1 in every 5 years, or may be confined to certain areas of the province or farm or to certain varieties.			
Cyclamen mite (as buds extend from the crown or immediately after harvest)	• Thiodan 50 WP or Endosulfan 50 W (7 days) • Thiodan 4 EC (7 days)	4.00 kg 4.00 kg 1.25 L	Apply one of these chemicals in 5,000–8,000 L of water/ha as a drench over the plant row.
Slugs (Preharvest)	• Metaldehyde bait		Most insecticides listed above have some activity on slugs. Distribute bait along edge of rows but not on strawberry plants. Keep children and domestic animals from treated areas. Read label about poisoning. Very poisonous to dogs.
Two-spotted spider mite (Preharvest or Post renovation)	• Kelthane 50 W (7 days) • Apollo SC (15 days)	2.00 kg 500 mL	Coverage of the underside of leaves is essential for good control. Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Apply no more than once/year. Thorough spray coverage of leaf undersides is required. Use high water volumes. To discourage resistance, alternate Apollo and Kelthane. Only apply Apollo once every 2 or more years.
Powdery mildew (Post renovation)	• Benlate 50 WP	1.10 kg	Consider application on susceptible varieties such as Governor Simcoe, Settler and Annapolis. Renovate old plantings immediately after harvest to decrease disease pressure.
Leaf blight Leaf scorch Leaf spot (Post renovation – Sept.)	• Copper 53 W (1 day) • Equal 65 WP (7 days)	3.80 kg 1.75 kg	Spray susceptible varieties such as Bounty, Kent, Veestar, Micmac, Tristar, and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays see Use of Copper Products on Fruit Crops, page 34. Equal may injure plants under cold weather conditions. Alternate between copper and Equal to reduce the development of resistance.
Red stele (Fall)			To reduce the chance of resistance developing, this application is only necessary where red stele has been observed and confirmed. Apply as an overall application in sufficient water (2500 L/ha) to ensure movement into the root zone.
	• Ridomil Gold 480 EC	1 L	Do not apply Ridomil Gold later than Oct. 31 or in the spring on established plants.
	• Aliette WDG	5.60 kg	With Aliette, make a maximum of 4 applications per season, 2 in spring and 2 in fall. Apply in spring when plants start active growth. Apply at 30–60 day interval. Do not apply within 30 days of harvest, or after first bloom. Post harvest applications should be made when soil conditions favour disease development (e.g., high soil moisture and cool soil temperatures).

Visit the berry page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/berry.html>

### White Grubs

White grubs are the larval stage of beetles, including June beetle, European chafer, and Japanese beetle. These beetles lay their eggs in grassy places. The eggs hatch into larvae, or white grubs and feed on plant roots. White grubs are C-shaped, with a tan or brown head capsule and 6 prominent spiny legs.

White grubs can be a pest in new strawberry plantings especially in light soil types. White grubs feed on plant roots, causing strawberry plants to be stunted.

There are no insecticides registered for white grub control on strawberries. Do not establish new plantings for 2 years after sod or pasture crops. Keep grassy weeds under control to make the habitat less favorable for white grubs.

Grass parking lots can serve as a large reservoir for the build-up of grubs. Treat these grass areas like turf or lawns but do not treat inside the planting. If 5 grubs per 1/10th of a m<sup>2</sup> (1 ft<sup>2</sup>) are found, treat with insecticide. There are 4 insecticides registered for use on grubs in turf: chlorpyrifos; diazinon; carbaryl and imidacloprid. Applications of chlorpyrifos, diazinon and carbaryl can be made between mid-July to mid-Sept. when eggs hatch and larvae begin to feed. Apply these insecticides according to label directions when soil is moist and grubs are feeding near the surface. Imidacloprid is registered for use on European chafer and Japanese beetle grubs only. It can only be applied during grub egg laying from June 1<sup>st</sup> to Aug. 1<sup>st</sup>. Immediately after applying the insecticides, thoroughly water to allow the insecticide to come in contact with grubs in the root zone just below the thatch (or grass mat layer). For more information on white grubs refer to OMAFRA Factsheet *Grubs in Lawns*, Order No. 97-023.

### Fruit Bronzing Caused by Thrips

Symptoms of fruit bronzing occur when king berries reach 5–10 mm in diameter. Close inspection of strawberry fruit will reveal a necrotic flecking or bronzing of the seeds and

fruits especially beneath the calyx. The entire fruit may become bronzed and cracked.

Most fruit bronzing is caused by flower thrips. Cyclamen mites and two-spotted spider mites can also cause bronzing. Thrips are tiny, yellow insects which begin feeding in the bloom, and, as the berry sizes and seeds separate, they begin feeding on the fruit.

Thrips do not overwinter in Ontario, but migrate each spring on air currents from the south. They are attracted to white flowers, and therefore to strawberry bloom that is open when the thrips arrive. They do not cause problems on strawberries every year.

Monitoring techniques and control strategies for thrips have not been worked out in Ontario. Insecticides applied for control of strawberry clipper weevil and tarnished plant bug also suppress thrips.

### Root Weevils

Root weevil larvae feed on strawberry roots causing plants to be stunted and die. The most common species in Ontario are the black vine weevil, the strawberry root weevil and the rough strawberry root weevil. Larvae of weevils are small, cream-coloured grubs that do not possess legs and are generally smaller than white grubs. Adults are beetles in the weevil family and can be identified by their characteristic long, probing mouthpart called a snout. The adults are wingless and migrate by crawling across land. Populations can build rapidly, within 2 years of planting.

When Furadan is applied for control of strawberry clipper weevil, it suppresses existing root weevil populations by killing early emerging adults and some larvae that may still be feeding. However, this timing is too early to kill the majority of emerging adults and too late to kill most larvae which have already finished feeding on the roots. Peak emergence and egg laying by adults occurs in July after harvest is completed.

# Disease Control

## Leather Rot

Leather rot can infect strawberry bloom, green fruit or mature fruit. Green fruit become hard and leathery. Ripe fruit develop a purplish color and a foul odor.

The use of Captan or Folpan for Botrytis control does reduce the incidence of leather rot, although they are not registered for the control of this disease. Rovral, Ronilan and Benlate do not control leather rot. Leather rot is worse under cool, wet, harvest conditions. Infection is more common where insufficient straw is applied. The most effective control for leather rot is a thick layer of straw mulch between the rows to prevent berries from touching the soil and soil from splashing to fruit.

## Angular Leaf Spot

Angular leaf spot causes angular dark green spots on the lower leaf surface. It can also spread to the sepals causing the fruit calyx to turn black, making fruit unmarketable.

Angular leaf spot is a bacterial disease and is not controlled by fungicides. Disease pressure is highest where frost has been frequent during bloom and overhead irrigation has been used to protect against frost. Cool spring conditions with frequent rainy periods are ideal for the development and spread of this disease.

Heavily fertilized and very vigorous plantings are most susceptible. If disease pressure is high all varieties can become infected. There is no evidence to date that copper sprays are effective in controlling angular leaf spot.

## Nematodes

Nematodes are microscopic wormlike creatures that live in soil and feed on strawberry roots. They can cause stunting of plant growth, and make plants more susceptible to Verticillium infection. Strawberries have a lower threshold than many other fruit crops for root lesion nematodes. Nematodes must be controlled before planting. For more information on nematodes and control, refer to *Nematodes in Berry Crops*, page 28.

TABLE 8-11. Effect of Fungicides on Strawberry Diseases\*

	Captan	Folpan (folpet)	Rovral (iprodione)	Ronilan (vinclozolin)	Equal (dodine)	Benlate (benomyl)	sulfur	copper	Ridomil (metalaxyl)	Allette (fosetyl-al)
Anthracnose ( <i>C. acutatum</i> )	++	++	0	0	0	0?	0	+P	0	0
Anthracnose ( <i>C. gloeosporioides</i> )	++	++	0	0	0	+R	0	+P	0	0
Gray mould	++	++	+++R	+++R	0	++R	0	+P	0	0
Powdery mildew	0	0	0	0	0	+R	++P	+P	0	0
Common leaf spot	+++	+++	++	++ to +++	++ R	++	0	+P	0	0
Leaf scorch					++R	++	0	+P	0	0
Phomopsis leaf blight and fruit rot	+ to ++	+ to ++	0	?	?	++	0	+P	0	++
Leather rot	+	+	0	0	0	0	0	+P	++	++
Angular leaf spot	0	0	0	0	0	0	0	+P	0	0
Phytophthora crown rot	0	0	0	0	0	0	0	0	++ to +++	++
Red stele root rot	0	0	0	0	0	0	0	0	++ to +++	++

\* Use fungicides only for control of diseases listed on the product label.

0 = no control + = poor to fair control ++ = good control, some limitations +++ = excellent control, few if any limitations

R = pathogen resistance (insensitivity) to the fungicide has occurred in some locations

P = may be phytotoxic

? = suspected level of control, needs confirmation.

Source: W. McFadden-Smith, University of Guelph, Vineland, based on information developed by the IR4 Project at the annual Small Fruit Workers Meeting, August 1999



TABLE 8-12. Strawberry Variety Disease Ratings

	Leaf Spot	Leaf scorch <sup>6</sup>	Powdery mildew	Botrytis rot	Verticillium	Red stele <sup>1</sup>					Bacterial angular leaf spot <sup>4</sup>
						Race C-2	Race C-3	Race C-4	Race C-6	Race C-7	
Allstar <sup>2</sup>	MR*	S	MR	MR	MR	R	MR	R	S	?	HS
Annapolis	MR	MR	S	S	MR	R	R	R	R	S	HS
Bounty	MR	MR	MR	MR	HS	R	S	S	R	R	S
Cavendish	MR	R	MR	MR	MR	R	R	R	R	S	HS
Chambly	R	MR	R	?	?	MR	S	?	S	?	?
Glooscap	MR	MR	MR	S	S	S	S	S	S	S	S
Gov. Simcoe	MR	MR	HS	MR	MR	S	S	S	S	S	S
Honeoye	MR	MR	MR	MR	HS	S	S	S	S	S	HS
Jewel <sup>3</sup>	HR	MR	HR	MR	S	S	S	S	S	?	HS
Kent	HS	S	MR	S	S	S-MR	S-MR	S	S	S	HS
Micmac	S	HS	MR	S	MR	S-MR	S-MR	S	S	S	S
Mohawk <sup>5</sup>	?	MR	MR	?	?	HR	HR	R	MR	?	?
Redcoat	MR	MR	MR	HS	S	S	S	?	S	S	MR
Scotland	MR	R	MR	MR	MR	?	?	?	?	?	?
Settler	MR	MR	HS	MR	MR	?	?	?	?	?	S
Sparkle	S	MR	MR	MR	S	S	HR	S	HR	HR	?
Startyme	S	S	S	?	?	?	?	?	?	?	?
Tribute	MR	MR	S	MR	R	MR	R	R	MR	?	?
Tristar	MR	MR	S	MR	R	R	R	R	MR	?	?
Vantage	R	R	R	MR	R	R	R	?	R	?	S
Veestar	S	MR	S	MR	MR	S	R	S	R	S	MR

HR — Highly Tolerant; R — Tolerant; MR — Moderately Tolerant; S — Susceptible; HS — Highly Susceptible; ? — Unknown

\* Race Dependent

<sup>1</sup> Red stele ratings from Dr. N. Nickerson and Dr. A. Jamieson, Agriculture & Agri-Food Canada, Kentville, Nova Scotia (1998): The following Canadian races equate to American Races C-2=A-6, C-3=A-4, C-4=A-3, C-6=A-7

<sup>2</sup> Gene Galletta, USDA, Maryland, (1991).

<sup>3</sup> Marvin Pritts, Cornell, N.Y. (1991)

<sup>4</sup> Based on field observation; subjective evaluation

<sup>5</sup> Galletta, Mass, Enns & Draper, 1995

<sup>6</sup> Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996

# 9. Grapes

## Growth Stages of Grapevine



**FIGURE 9-1. Wool stage**



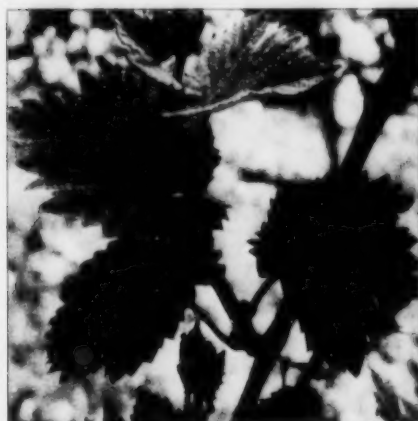
**FIGURE 9-2. Bud burst**



**FIGURE 9-3. First leaf unfolded**



**FIGURE 9-4. Two-3 leaves unfolded**



**FIGURE 9-5. Inflorescence visible**



**FIGURE 9-6. Inflorescence swelling**



**FIGURE 9-7. Beginning of flowering**



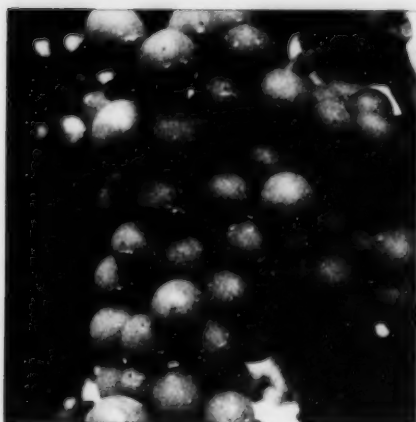
**FIGURE 9-8. Fruit set**



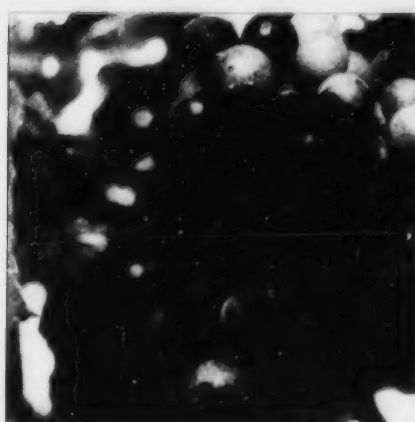
**FIGURE 9-9. Berries lead shot (3 mm)**



**FIGURE 9-10. Berries pea-sized**



**FIGURE 9-11. Berry touch**



**FIGURE 9-12. Beginning of ripening**

Source: Reprinted with permission from Novartis

# Grape Nutrition

Soil preparation and soil testing before planting vines is important. Well in advance of planting, prepare the soil through tillage and additions of organic matter, to ensure long term productivity of these perennial crops. For information on building and maintaining soil organic matter see *Managing Soil Organic Matter* on page 20 and *Manure for Vineyards*, below.

Prior to planting, ensure that nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to *Fertilizer for Grapes* on page 102. Phosphorus, potassium and lime do not move readily through the soil and pre-plant applications are the most effective.

## Manure for Vineyards

A spring application of manure is beneficial in providing nutrients and organic matter to established vineyards. Manure can also be applied in the fall prior to new spring plantings.

Broadcast manure at no more than 7 tonnes/ha of poultry manure (20 m<sup>3</sup> liquid), 40 t/ha of cattle (100 m<sup>3</sup> liquid) or 35 t/ha hog (65 m<sup>3</sup> liquid). Manure is extremely variable in nutrient content and should be analyzed before application. When manure is used, reduce the rate of fertilizer. Table 3-5, page 21, shows the average composition of some manure and the suggested reduction of fertilizer when manure is used.

Nitrogen is released over a prolonged period of time. Perennial crops will be supplied with nitrogen during the year. This may result in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue, and make plants more susceptible to winter injury. The practice of putting manure around newly planted vines is not recommended because of potential winter injury problems.

## pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. To determine pH, take a soil sample. For information on soil sampling, consult *Soil Testing* on page 15.

Always take a soil sample before establishing a new planting. If lime is required, it should be incorporated during soil preparation. In established vineyards a soil sample in the vine row is recommended every 3 years to ensure that the pH is at a satisfactory level. If pH is low (acidic), lime can be applied to the sod cover in the fall, or before cultivation in the spring. The results will not be immediately evident because the lime moves slowly into the soil.

The preferred pH before establishing a new vineyard is 6.5 on sandy soils and 6.0 on clay soils. If the pH in established vineyards is above 5.6, lime is not needed. Lime should be applied to established vineyards, when the pH on clay loam soils drops below 5.1, and on sandy soils is below 5.6. Lime will raise the soil pH, reducing its acidity and also supplying calcium. Use dolomitic lime (high in magnesium) on soils low in magnesium. Rates of application will vary with soil type and initial pH. The buffer pH indicates the rate of lime to apply. For information on lime, consult *Soil Acidity And Liming* on page 18.

## Petiole Analysis for Grapes

In established plantings, petiole analysis in grapes is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop. Soil analysis is used in conjunction with petiole analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests consult *Plant Analysis* on page 17.

**TABLE 9-1. Nutrient Level Range (% Dry Weight) of Grape Petioles (taken in September from mature vines)**

Petiole Analysis	Nitrogen		Potassium*		Magnesium
	Low if below	High if above	Low if below	High if above	Low if below
<b>GRAPE</b>					
Vinifera	0.8	1.4	1.2	2.3	0.6
Fredonia	0.6	1.2	0.8	1.8	0.6
Other cultivars	0.7	1.3	1.0	2.0	0.6

\* Potassium levels will be higher with grapes grown on sandy loam soils.

Nutrient uptake is affected by many vineyard conditions. Consequently, each year the nutrient levels will vary slightly depending upon the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the petioles and the relative amounts must be balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

For petiole analysis to be most effective, sample the same vines each year. Make adjustments to the fertilizer program on the basis of this petiole analysis. For nutrient level ranges determined by petiole analysis, consult Table 9-1, *Nutrient Level Range of Grape Petioles*.

Fertilizer requirements are adjusted to the system of soil management, vine age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour, and storage quality must also be considered in determining the fertilizer required.

## Fertilizer for Grapes

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Nutrient levels in the topsoil considered to be adequate for vineyard establishment are 12-20 ppm phosphorus, 120-150 ppm potassium, 100-250 ppm magnesium, and 1000-5000 ppm calcium. Table 9-2, *Phosphorus and Potassium Requirements for Grapes*, provides information on fertilizer rates prior to planting.

If the soil has been properly prepared, including deep cultivation and addition of organic matter, there should be an adequate supply of other nutrients to sustain the vine in the juvenile years. On coarse-textured, infertile soils, the use of a starter solution at planting time (e.g., 10-52-10 or 20-20-20) may give the vines a needed boost. High nitrogen levels can result in excessive growth and incomplete vine hardening. The use of cover crops to check late season growth in cultivated vineyards is strongly recommended, especially in new plantings. Cover crops such as Italian rye grass, sown about July 1, will take up much of the available nitrogen in the soil and in this way have the desirable effect of checking vine growth.

**TABLE 9-2. Phosphorus & Potassium Soil Requirements Before Planting Grapes**

Soil Phosphorus	New plantings of grapes	Soil Potassium	New plantings of grapes
Soil Test (ppm P)	Phosphate ( $P_2O_5$ ) req'd kg/ha	Soil Test (ppm K)	Potash ( $K_2O$ ) req'd kg/ha
0-3	80 L	0-15	270 L
4-5	60 L	16-30	270 L
6-7	50 L	31-45	270 L
8-9	40 M	46-60	270 L
10-12	20 M	61-80	270 L
13-15	0 H	81-100	270 L
16-20	0 H	101-120	270 L
21-25	0 VH	121-150	270 M
26-30	0 VH	151-180	270M
31-40	0 VH	181-210	270 M
41-50	0 VH	211-250	270 H
51-60	0 VH	250 +	270H
61-80	0 E		
80 +	0 E		

\* For established grapes, plant analysis is used to estimate requirements of N, P + K

## Nitrogen (N)

Petiole analysis is the most accurate way to determine nitrogen requirements of grapes. For information on this test, consult *Soil Testing* on page 15 and *Plant Analysis* on page 17. In the absence of such information, 34 kg N/ha is usually sufficient for most cultivars. This nitrogen is best broadcast before the first cultivation or applied as early as possible in the spring in sod vineyards. Nitrogen application can be reduced or eliminated if manure is used or growth has been excessive. For more information on manure, consult *Manure for Vineyards* on page 101. Consult Table 9-1 for petiole analysis values. Foliar applications of N should be considered in some years, based on vine performance and petiole analysis.

If there has been fruit bud damage because of severe winter temperatures it may be necessary to split applications. Apply the first application in mid April and the second application, if necessary, after bloom in late May. Excessive spring rains can leach away spring applied nutrients. Apply additional fertilizer or foliar sprays after bloom. During dry springs, irrigation may be necessary to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall.



# Grape Nutrition

## Phosphorus (P)

Phosphorus is not required in large amounts by grapes. With few exceptions, the level of phosphorus in Ontario soils is presently adequate. Phosphorus does have a place for sod or cover crop maintenance. A soil test is the best way to determine if there is a need to apply this nutrient to the sod cover. In the absence of a soil test, a complete fertilizer (100 kg/ha 10-20-20) could be broadcast and incorporated before seeding a cover crop in a vineyard. Phosphorus should also be applied before planting a vineyard when it can be thoroughly incorporated in the soil if a soil test indicates a need. Phosphorus soil test values between 12-20 ppm are considered adequate for vineyard establishment and production

## Potassium (K)

An excess amount of potassium can lead to deficiency of magnesium (Mg), so take care when deciding upon potassium rates. Grapes require a larger quantity of potassium than tree fruits. In the absence of petiole analysis, 400 kg/ha of muriate of potash (0-0-60) every second year on clay soil and 200 kg/ha every year on sandy soil may be adequate.

In cultivated vineyards, potassium may be broadcast before the first cultivation in the spring. With grapes on clay soils, it is advantageous to apply potassium in a band to reduce fixation. Potash can injure roots and trunks if applied too closely to the trunk.

### *Foliar application of potassium for grapes*

In dry growing seasons potassium is not readily available to the plant. Where a potassium deficiency has been confirmed, foliar applications of potassium may be beneficial. Foliar potassium applied at veraison may improve fruit yield and quality.

## Magnesium (Mg)

Magnesium deficiency is becoming more evident in vineyards, particularly when high rates of potash are used.

Magnesium deficiency can lead to premature fruit drop at harvest. Magnesium deficient vines have older leaves that are

pale in colour, as magnesium is a part of the chlorophyll molecule. Petiole analysis is the best way to evaluate Mg levels.

Foliar sprays of magnesium have been effective in correcting this deficiency for the current year only. For more permanent correction, soil applications of Mg may be required. Magnesium soil test values between 100-250 ppm are considered adequate for grapes. See Table 9-3, *Magnesium Foliar Sprays*.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. It is best to apply magnesium sulfate separately or try it on a few plants first. Check manufacturer's label regarding mixing magnesium chelates<sup>1</sup> with pesticides.

For long-term corrections, soil application of Mg can be made. The response will not likely be immediate. Also, on some soil types a single early spring application of soil applied Mg has not worked well. A second or third application the following spring may be required before the Mg level in the plant improves. Foliar sprays are recommended for the first two years, in addition to soil applications.

Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply Mg.

## Calcium (Ca)

Calcium deficiency has been associated with stem and bunch breakdown of Canada Muscat and Himrod grapes. Some formulations of calcium chloride (CaCl<sub>2</sub>) have resulted in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective. Apply adequate water volume to wet the entire vine. The more calcium that can be applied, the better the control, but there is a concentration at which calcium can cause foliar burning. Use CaCl<sub>2</sub> (77% flakes) at 4 kg/1000 L of water from early July to mid Aug. Apply three sprays, 10-12 days apart. Do not apply Ca formulations containing nitrogen after the end of July or fruit quality may suffer.

1. Use chelates recommended for foliar sprays.

TABLE 9-3. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 10 days apart beginning in mid July	Magnesium sulfate (Epsom salts)	20 kg/1000 L water	Wet plant to point of run-off. Do not concentrate beyond 40 kg/1000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

\* Use chelates recommended for foliar sprays.

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For all the formulations, be sure to consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual Ca is often required in a total of 4, or more, sprays. Ca sprays may damage foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

## Micronutrients for Grapes

Deficiencies of micronutrients or trace elements are not wide spread in Ontario plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Only the nutrient that is deficient should be applied in sufficient quantities to correct the problem.

### Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency can have an effect on growth and fruiting. There is currently no accredited soil test for boron in Ontario. Use a petiole analysis to check for boron deficiencies. Boron levels should be 20–60 ppm. Where a boron deficiency has been confirmed, soil or foliar applications of boron may improve boron in plant tissues. There are several sources of boron, check the manufacturer's recommended rates and timing of applications.

### Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, soil tests can be used to determine the status of manganese in the soil. Soil manganese index values greater than 8 should provide adequate manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate. Use manganese sulphate with a spreader sticker. Soil applications of manganese are not effective. Consult

manufacturer's label for complete information on rates and timing.

### Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the plant is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a petiole analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates<sup>1</sup> have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

### Zinc

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch die back. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to petiole analysis, soil tests can be used to determine the status of zinc in the soil. A soil zinc index value greater than 8 should provide adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

**Warning: Do Not Concentrate Nutrient Sprays**

Visit the grape page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/grape.htm>

1. Use chelates recommended for foliar sprays.

**Read the label and follow all safety precautions.**  
**Some grape varieties are sensitive to Sulphur, Dikar, Dikar plus Zolone, Thiodan or Copper.**  
**See Table 9-4 on page 111 for specific information.**

To delay development of resistance to NOVA do not apply more than three times per season.

Avoid repeated applications of synthetic pyrethroids, such as Cymbush and Pounce. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 26 for more information.

Be aware that many processors may need longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Some processors also have special restrictions for certain pest control products, for example, number of applications or no application after a certain crop stage. Consult the contract purchaser of your grapes for more details.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>First Leaf to Inflorescence (flower cluster) Visible</b>			
Phomopsis cane and leaf spot	• Captan 50 WP	3.25 kg	Spray varieties where phomopsis is a problem, when new shoots are 1.25–5 cm long, and again when 10–15 cm long. Apply in high water volume to ensure complete coverage.
	• or Captan 80 WP	2.00 kg	
	• or Maestro 75 DF	2.50 kg	
	• Folpan 50 WP	3.25 kg	
<b>Inflorescence (flower cluster) Fully Developed</b>			
Grape berry moth	• <sup>4</sup> Guthion 50 WP	1.10 kg	Where there has been a history of grape berry moth injury from the previous year, an application of an insecticide for first generation may prove to be economically beneficial. Apply in high water volumes to ensure complete coverage.
	• or <sup>4</sup> Guthion 240 SC	2.00 L	
	• or <sup>4</sup> APM 50 W	1.10 kg	
	• or <sup>4</sup> Sniper 50 W	1.25 kg	
	• Sevin XLR Plus	3.25 L	Warning: Under slow drying conditions or at temperatures above 24°C, any spray material or combinations are likely to cause some degree of injury.  Apply Isomate GBM in late April or early May prior to 1 <sup>st</sup> catch and flight and mating of grape berry moth (GBM) adult moths. Use the higher rate of 1000 dispensers at high risk site locations. Vineyard block must be larger than 2 ha for treatment. Isomate GBM is specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is being adequately controlled and to time special sprays for other sporadic pests such as leafhoppers. For more information see note on mating disruption, page 109.
	• Imidan 50 WP	1.90 kg	
	• Diazinon 50 W	1.75 kg	
	• Cymbush 250 EC	240 mL	
	• Pounce 384 EC	360 mL	
	• Isomate GBM	625–1000 dispensers	
Downy mildew	• Ridomil Gold MZ 68 WP	2.50 kg	If bloom is delayed or if wet weather is expected, repeat the application. Ridomil Gold MZ may be used only once per season and only prior to bloom.
	• Dithane M45 80 WP	3.25 kg	
	• or Manzate 200 80 WP	3.25 kg	
	• Dikar WP	3.25 kg	
	• Polyram 80 DF	3.25 kg	
	• Maestro 75 DF	2.50 kg	
	• or Captan 50 WP	3.25 kg	
	• or Captan 80 WP	2.00 kg	
	• Folpan 50 WP	3.25 kg	

<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.

For all the formulations, be sure to consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual Ca is often required in a total of 4, or more, sprays. Ca sprays may damage foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

## Micronutrients for Grapes

Deficiencies of micronutrients or trace elements are not wide spread in Ontario plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Only the nutrient that is deficient should be applied in sufficient quantities to correct the problem.

### Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency can have an effect on growth and fruiting. There is currently no accredited soil test for boron in Ontario. Use a petiole analysis to check for boron deficiencies. Boron levels should be 20–60 ppm. Where a boron deficiency has been confirmed, soil or foliar applications of boron may improve boron in plant tissues. There are several sources of boron, check the manufacturer's recommended rates and timing of applications.

### Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, soil tests can be used to determine the status of manganese in the soil. Soil manganese index values greater than 8 should provide adequate manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate. Use manganese sulphate with a spreader sticker. Soil applications of manganese are not effective. Consult

manufacturer's label for complete information on rates and timing.

### Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the plant is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a petiole analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates<sup>1</sup> have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

### Zinc

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch die back. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to petiole analysis, soil tests can be used to determine the status of zinc in the soil. A soil zinc index value greater than 8 should provide adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

**Warning: Do Not Concentrate Nutrient Sprays**

Visit the grape page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/grape.html>

1. Use chelates recommended for foliar sprays.



**Read the label and follow all safety precautions.**  
**Some grape varieties are sensitive to Sulphur, Dikar, Dikar plus Zolone, Thiodan or Copper.**  
**See Table 9-4 on page 111 for specific information.**

To delay development of resistance to NOVA do not apply more than three times per season.

Avoid repeated applications of synthetic pyrethroids, such as Cymbush and Pounce. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 26 for more information.

Be aware that many processors may need longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Some processors also have special restrictions for certain pest control products, for example, number of applications or no application after a certain crop stage. Consult the contract purchaser of your grapes for more details.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>First Leaf to Inflorescence (flower cluster) Visible</b>			
Phomopsis cane and leaf spot	• Captan 50 WP	3.25 kg	Spray varieties where phomopsis is a problem, when new shoots are 1.25–5 cm long, and again when 10–15 cm long. Apply in high water volume to ensure complete coverage.
	• or Captan 80 WP	2.00 kg	
	• or Maestro 75 DF	2.50 kg	
	• Folpan 50 WP	3.25 kg	
<b>Inflorescence (flower cluster) Fully Developed</b>			
Grape berry moth	• <sup>4</sup> Guthion 50 WP	1.10 kg	Where there has been a history of grape berry moth injury from the previous year, an application of an insecticide for first generation may prove to be economically beneficial. Apply in high water volumes to ensure complete coverage.  Warning: Under slow drying conditions or at temperatures above 24 °C, any spray material or combinations are likely to cause some degree of injury.  Apply Isomate GBM in late April or early May prior to 1 <sup>st</sup> catch and flight and mating of grape berry moth (GBM) adult moths. Use the higher rate of 1000 dispensers at high risk site locations. Vineyard block must be larger than 2 ha for treatment. Isomate GBM is specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is being adequately controlled and to time special sprays for other sporadic pests such as leafhoppers. For more information see note on mating disruption, page 109.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
	• or <sup>4</sup> Guthion 240 SC	2.00 L	
	• or <sup>4</sup> APM 50 W	1.10 kg	
	• or <sup>4</sup> Sniper 50 W	1.25 kg	
	• Sevin XLR Plus	3.25 L	
	• Imidan 50 WP	1.90 kg	
	• Diazinon 50 W	1.75 kg	
	• Cymbush 250 EC	240 mL	
	• Pounce 384 EC	360 mL	
	• Isomate GBM	625–1000 dispensers	
Downy mildew	• Ridomil Gold MZ 68 WP	2.50 kg	If bloom is delayed or if wet weather is expected, repeat the application. Ridomil Gold MZ may be used only once per season and only prior to bloom.
	• Dithane M45 80 WP	3.25 kg	
	• or Manzate 200 80 WP	3.25 kg	
	• Dikar WP	3.25 kg	
	• Polyram 80 DF	3.25 kg	
	• Maestro 75 DF	2.50 kg	
	• or Captan 50 WP	3.25 kg	
	• or Captan 80 WP	2.00 kg	
	• Folpan 50 WP	3.25 kg	

Diseases and Insects	Materials	Amount per Hectare	Comments
Powdery mildew	<ul style="list-style-type: none"> <li>Nova 40 WP</li> <li>Dikar WP</li> <li>Sulphur 92 WP or Kumulus 80 DF</li> <li>Benlate 50 WP</li> </ul>	200 g 4.50 kg 9.00 kg 12.60 kg 1.10 kg	This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to powdery mildew during the bloom and petal fall stage. Do not stretch the intervals between Nova applications beyond 14 days. Do not use Nova more than 3 times per season. For other products, intervals between sprays need to be about 7–10 days. Under rainy conditions, intervals may need to be shortened. 7 day intervals over the bloom period would be ideal.
Black rot	<ul style="list-style-type: none"> <li>Nova 40 WP</li> <li>Ferbam 76 WDG</li> <li>Benlate 50 WP</li> </ul>	200 g 3.25 kg 850 g	

Do not apply insecticides while grapes are in bloom.

See Bee Poisoning, page 41.

## End of Late Flowering to Fruit Set Stage

Leafhoppers	<ul style="list-style-type: none"> <li>Guthion 50 WP or Guthion 240 SC</li> <li>APM 50 WP or Sniper 50 W</li> <li>Sevin XLR Plus</li> <li>Diazinon 50 W</li> <li>Cymbush 250 EC</li> <li>Pounce 384 EC</li> </ul>	1.50 kg 2.75 L 1.50 kg 1.25 kg 4.50 L 2.25 kg 240 mL 175 mL	Grape leafhopper (GLH) and potato leafhopper (PLH) are the two main species that feed on grapes. GLP causes pale white stippling along the veins and eventually the leaf may die. In some vineyards, Guthion or APM no longer give control. PLH feeding causes the leaves to yellow along the margins. Leaves cup upwards and later develop marginal necrosis. All products listed provide control of PLH. <i>*Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</i>
Grape phylloxera (leaf form)	<ul style="list-style-type: none"> <li>Thiodan 50 WP or Endosulfan 50 W</li> </ul>	2.25 kg	Only French hybrid and vinifera varieties are susceptible to this pest.
Downy mildew	<ul style="list-style-type: none"> <li>Ridomil Copper 70 WP plus Lime</li> <li>Dithane M45 80 WP or Manzate 200 80 WP</li> <li>Dikar WP</li> <li>Polyram 80 DF</li> <li>Maestro 75 DF or Captan 50 WP or Captan 80 WP</li> <li>Folpan 50 WP</li> </ul>	2.20 kg 3.50 kg 4.25 kg 4.25 kg 4.25 kg 4.50 kg 2.50 kg 4.25 kg 2.25 kg 4.25 kg	Spray all varieties for mildew at this time. Captan or Folpan may suppress Botrytis when used at this stage. Ridomil Copper may cause injury to many varieties under cool, slow drying conditions. Do not use more than 3 times per season. Ridomil-Copper mixtures should not be used in combination with other products.
Black rot	<ul style="list-style-type: none"> <li>Nova 40 WP</li> <li>Folpan 50 WP</li> <li>Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>Polyram 80 DF</li> </ul>	200 g 4.25 kg 4.25 kg 2.25 kg 2.50 kg 4.25 kg	
Powdery mildew	<ul style="list-style-type: none"> <li>Nova 40 WP</li> <li>Sulphur 92 WP or Kumulus 80 DF</li> <li>Dikar WP</li> <li>Benlate 50 WP</li> </ul>	200 g 9.00 kg 12.6 kg 4.50 kg 1.10 kg	Do not stretch the intervals between Nova applications beyond 14 days. Do not use Nova more than 3 times per season. For other products, intervals between sprays need to be about 7 days. Under rainy conditions intervals may need to be shortened. Young developing fruit and leaves are very susceptible at this stage. It is important that protectant coverage be maintained.
Botrytis bunch rot	See comments for Botrytis bunch rot control under <b>Beginning of Berry Touch.</b>		

## Berries Lead-shot to Berries Pea-sized

Grape berry moth	<ul style="list-style-type: none"> <li>Guthion 50 WP or Guthion 240 SC</li> <li>APM 50 W or Sniper 50 W</li> <li>Sevin XLR Plus</li> <li>Imidan 50 WP</li> <li>Diazinon 50 W</li> <li>Cymbush 250 EC</li> <li>Pounce 384 EC</li> <li>Isomate GBM</li> </ul>	1.75 kg 3.10 L 1.75 kg 1.25 kg 5.50 L 3.10 kg 2.75 kg 240 mL 360 mL 625–1000 dispensers	Where berry moth is a regular problem, apply one of these materials in high water volumes to ensure complete coverage. <b>Mating Disruption:</b> Apply second application of Isomate GBM dispensers 60 days after your first application (about late June or early July) but before significant second flight of grape berry moth (GBM). Vineyard block must be larger than 2 ha for treatment. Isomate GBM is specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is being adequately controlled and to time special sprays for other sporadic pests such as leafhoppers. For more information see note on mating disruption, page 109. <i>* Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</i>
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Diseases and Insects	Materials	Amount per Hectare	Comments
Phylloxera (leaf form)	Repeat as in <b>End of Late Flowering to Fruit Set Stage.</b>		
Powdery mildew	• Nova 40 WP	200 g	<b>If you have used 2 applications of Nova already as pre-bloom and post-bloom sprays, do not use in a third consecutive spray. Nova should not be used more than 3 times per season.</b> These 2 points are key components in a resistance management strategy.
	• Dikar WP	5.50 kg	
	• Sulphur 92 WP or Kumulus 80 DF	11.0 kg	
	• Benlate 50 WP	1.50 kg	
	• Folpan 50 WP	5.50 kg	
Downy mildew	• Dikar WP	5.50 kg	Ridomil-Copper may cause injury to many varieties under cool, slow drying conditions. Do not use more than 3 times per season. Ridomil-Cooper mixtures should not be used in combination with other products.
	• Folpan 50 WP	5.50 kg	
	• Captan 50 WP	5.50 kg	
	or Captan 80 WP	3.25 kg	
	or Maestro 75 DF	3.50 kg	
	• Polyram 80 DF	5.50 kg	
	• Dithane M45 80 WP	5.50 kg	
Black rot	• Ridomil/Copper 70 WP plus lime	2.20 kg	For effective control, apply in high water volumes to ensure coverage.
		3.50 kg	
	• Folpan 50 WP	5.50 kg	
	• Captan 50 WP	5.50 kg	
	or Captan 80 WP	3.25 kg	
	or Maestro 75 DF	3.50 kg	
	• Polyram 80 DF	3.25 kg	

#### Beginning of Berry Touch to Berry Touch

Powdery mildew	• Nova 40 WP	200 g	
	• Sulphur 92 WP	11.00 kg	
	or Kumulus 80 DF	12.6 kg	
	• Dikar WP	5.50 kg	
	• Benlate 50 WP	1.50 kg	
Black rot	• Nova 40 WP	200 g	Apply a fungicide if Black rot symptoms are found on fruit or leaves. For effective control, apply in high water volumes to ensure coverage.
	• Ferbam 76 WDG	4.50 kg	
	• Benlate 50 WP	1.25 kg	
Botrytis bunch rot	• Rovral 50 WP	1.50 kg	Many of the vinifera and vinifera hybrid varieties with tight bunches are susceptible to Botrytis bunch rot e.g., Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Chancellor, and Seyval Blanc.
	• 'Elevate 50 WDG	1.10 kg	
	• 'Vanguard 75 WG	750 g	

These susceptible varieties may require more than one application during the bunch closure period. **For Elevate use Agral 90 at 200 mL per 1000 L of water (0.02% v/v) with the product in the tank. Do not apply Elevate if rainfall is expected within 6 hrs. after application. Do not apply Vanguard within 30 m of lakes, streams and ponds.**

Because all of these products have a high risk of selecting fungicide resistant populations of Botrytis, the following steps should be taken to avoid rapid development of resistance:

- apply each product no more than once per season
- never use a product in consecutive or back to back sprays
- do not cut label rates.

To maximize the effectiveness of all products:

- direct the full recommended spray rate to the fruiting zone of the grape canopy for best disease control
- use a minimum of 1000 L/ha (100 gal/acre) of water or sufficient water to provide good coverage of the fruiting zone and apply as a special separate cover spray.

<sup>1</sup>Minimum period for reentry is 4 hrs. See product label for specific reentry requirements and precautions.

<sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Beginning of Ripening to Late Stage of Ripening (veraison period)</b>			
Powdery mildew	Use one of the materials listed under <b>Beginning of Berry Touch to Berry Touch</b> . Check for interval to harvest.		Vinifera and french hybrid varieties are more susceptible and may require extra sprays.
Downy mildew	Use one of the materials listed under <b>Berries Lead-shot to Berries Pea-sized</b> .		Ridomil-Copper may cause injury to many varieties under cool, slow drying conditions. Do not use more than 3 times/season. Ridomil-Copper mixtures should not be used in combination with other products.
Grape berry moth about Aug. 20	Use one of the materials listed under <b>Berries Lead-shot to Berries Pea-sized</b> .		Check the interval to harvest. A spray may be needed on late varieties to control the brood which emerges in late Aug. Border sprays may be very effective.
Botrytis bunch rot	<ul style="list-style-type: none"> <li>• Rovral 50 WP</li> <li>• 'Elevate 50 WDG</li> <li>• 'Vanguard 75 WG</li> </ul>	1.50 kg 1.10 kg 750 g	In years when late summer or fall weather conditions are wet and humid, additional sprays to protect against Botrytis may be necessary during the ripening or veraison period. This is especially important for vineyards designated for late harvest or ice wine. For further information on product choice and use, see comments under <b>Beginning of Berry Touch</b> . <i><sup>1</sup>Minimum period for reentry is 4 hrs. See product label for specific reentry requirements and precautions.</i> <i><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</i>
<b>Post Harvest</b>			
Powdery mildew	<ul style="list-style-type: none"> <li>• Sulphur 92 WP or Kumulus 80 DF</li> <li>• Dikar WP</li> <li>• Benlate 50 WP</li> <li>• Copper sulphate plus Lime</li> <li>• Copper 53 WP plus Lime</li> </ul>	11.00 kg 12.60 kg 5.50 kg 1.25 kg 4 kg/1000L 6 kg/1000L 3 kg/1000L 6 kg/1000L	Infection by powdery mildew after harvest may leave canes more susceptible to winter injury. Varieties sensitive to mildew should receive 1 or 2 sprays after harvest to protect the wood. Some premature defoliation may be observed when using Sulphur, Kumulus, or Copper mixtures, but is not likely to affect vine vigour. Rates for copper and lime are given as rates per 1000 L/water. Post harvest applications of Copper also assist in curing or maturing the new wood which has often helped increase the winter hardiness of the canes. Use sufficient water volume to ensure complete coverage of the vine. See <i>Use of Copper Products on Fruit Crops</i> on page 34 for information on how to mix copper sprays.

Visit the grape page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/grape.html>

# Insect Control

## Mating Disruption Technology (MD) for Grape Berry Moth

Adult female insects of many species emit volatile chemicals known as sex pheromones to attract male members of the same species to mate. The production of synthetic pheromones has led to the development and widespread commercial use of pheromone traps for monitoring and trapping insect pests in agriculture, forestry, government detection and quarantine programs. The potential for using sex pheromones to directly control insect pests was first demonstrated 30 years ago. The release of large amounts of synthetic sex pheromone into the atmosphere of a crop interferes with mate location and controls the pest by preventing mating. Unmated females lay non-fertilized eggs that will not hatch and develop into fruit infesting larvae.

In Canada, there is presently 1 registered product for the control of the grape berry moth — Isomate GBM. To control the grape berry moth (GBM) with mating disruption technology, pheromone dispensers are applied uniformly through the vineyard. The resulting high concentration of pheromone makes it difficult for male moths to locate female moths within the crop canopy. While conventional insecticides provide broad-spectrum control of both target and non-target insects such as beneficials, the use of mating disruption technology provides control specific to the grape berry moth. Other pests (e.g. mites and leafhoppers) and beneficial insects and mites present in the vineyard remain active and unaffected. You should conduct intensive monitoring for sporadic pests once a week to assess whether you need to apply insecticides to control these pests.

It is anticipated that over the next few years the understanding of mating disruption technology and the availability of different mating disruption pheromone products will expand.

### Choosing a Site for Mating Disruption

Vineyards should be at least 4 ha in size. Mating disruption works best in vineyards with low insect populations. Therefore select vineyards with known low populations of grape berry moth. Avoid vineyards located next to vineyards with known high populations of grape berry moth.

### Application of Pheromone Dispensers

Make 2 applications of pheromone dispensers per season at the manufacturer's recommended rate. Make the first

application approximately May 1–20, prior to the first grape berry moth emergence in the spring. Application of pheromone may vary considerably from year to year based on changes in the weather and the subsequent emergence of the grape berry moth.

Consider the length of time it will take to treat the whole farm. The purpose of MD is to prevent or disrupt mating. If temperatures are favourable, moths mate within 24 hrs. after emergence. If the dispensers are applied after emergence, significant mating can occur. Success is seldom achieved once mating has occurred in a MD vineyard. Make the second application of pheromone approximately 60 days later. (i.e. 15 July–1 August).

Apply pheromone dispensers uniformly throughout the vineyard. Attach dispensers securely to the upper training wire close to the vines. Wear gloves when making the application.

### Monitoring for Grape Berry Moth

Use 1 pheromone trap per 5 ha. Place traps along a line that transects the vineyard. In addition, place at least 1 extra trap along the windward edge of the vineyard. Bait the traps with commercial lures available from local distributors of agricultural chemicals. Inspect traps weekly and note the number of moths. Replace lures every 4 weeks. Captures of moths in pheromone traps should be very low to zero. If more than 2 moths per 5 traps in total are caught during a flight period of a generation, apply supplemental insecticides, using the appropriate timing.

Inspect vineyards weekly for signs of fruit infestation. Make the inspections along a transect. In addition, carefully inspect border areas, especially those on the windward side, for signs of fruit infestation. If more than 5% of the grape clusters are infested with grape berry moth larvae, apply supplemental insecticides using the appropriate timing.

Mating disruption technology prevents mating of grape berry moth adults. However, if a source of mated female moths of this species is present in adjacent areas, migration of these moths into a pheromone treated vineyard may significantly reduce the level of control achieved. Sources of mated females are likely to be unsprayed vineyards or wild grapevines within 100 m of the treated vineyard. Migration of mated females can be prevented by:



- treating entire blocks, not just sections of large conventionally treated fields, with pheromone dispensers
- treating sources of infestation with pheromone dispensers

- treating infestation source(s) with an effective insecticide and
- treating edges of vineyard with timely insecticide applications.

## Disease Control

### Use of Nova 40 W on Grapes

Nova is a member of the SI (sterol inhibitor) group of fungicides. It must be used differently from the "protectant" fungicides such as captan or mancozeb.

SI fungicides are systemic and must be absorbed by the leaf and fruit tissue to be effective. Nova will be absorbed within an hour of application, and effectiveness is not reduced if rain occurs more than one hour after application.

Nova does not redistribute well after application. Therefore, uniform spray coverage is essential for good disease control.

Nova gives good control of powdery mildew and black rot, but not downy mildew or Botrytis bunch rot. If downy mildew control is required, combine Nova with Dithane M-45, which controls downy mildew. The maximum number of applications per season is 3, beginning at pre-bloom.

### Crown Gall Disease of Grapevine

Crown gall, caused by the bacterium *Agrobacterium vitis*, (*A. vitis*), is a serious problem where grapes are grown in climatic conditions which favor freeze injury. Severely diseased vines usually exhibit significant reductions in yield and vigor, predisposing them to winter kill.

#### Cultural Practices for Crown Gall Control

**Use best available nursery stock.** Latently infected nursery stock is the major source of infection. Grafting wood from warm climates often harbors the pathogen that induces crown gall symptoms in vines grown in cooler climates. Hot water treatment of nursery stock prior to grafting has been shown to significantly reduce levels of crown gall infection. At present, no commercially available crown gall free certified nursery stock is available in Canada, although several nurseries are currently evaluating heat treatment.

Use the following management practices to reduce injury, since crown gall is closely correlated with the occurrence of injury.

- For new plantings, **select sites with good soil and air drainage** not prone to freeze injury.
- **Select hardy, cold tolerant cultivars where possible.** Do not plant cold sensitive varieties in marginal areas with poor soil drainage and exposure to cold temperatures.
- **Hill up trunks in the fall** with soil to protect the crown from cold temperatures. This ensures new shoots for trunk renewal or replacement the following season.
- **Avoid injuring vines during cultivation**, since the soil inhabiting pathogen enters through wounds, particularly in spring and early summer.

**Fallowing the land and planting other crops** for several years may reduce or eliminate *A. vitis* from the soil. Infected roots left in the soil after vine removal are a reservoir of inoculum. These systemic populations likely lead to greater persistence of the pathogen in the field. By using clean planting stock and managing soil populations of *A. vitis* you may provide effective control of crown gall because:

- *A. vitis* has not been detected in soils where grapevines have not been grown
- levels of soilborne *A. vitis* decline in the absence of grapevines
- low levels of *A. vitis* fail to increase around grapevine roots.

**Train multiple trunks** of differing ages to allow renewals to replace trunks killed by cold temperatures or by crown gall. This does not eliminate the pathogen, but it helps ensure a crop, allowing you to manage the disease at a tolerable level.

**Topical chemical treatments are ineffective** because the pathogen is systemic in the grapevine and new galls will develop around or beyond the treatment site. Soil fumigation is generally ineffective, particularly in heavier soils, but also in light textured soils where roots often extend deeper than the fumigant application. The pathogen can remain viable in the soil as long as infected living grape root material is present.

**Apply nitrogen in early spring. Avoid excessive rates.** Vines that grow late in the season do not adequately harden off and have a higher water content going into winter. These vines are more prone to winter injury and crown gall infection. Rapid growth in the spring can cause bark splitting which can act as entry points for infection.

**When removing diseased vines from a vineyard, remove as much of the root system as possible before replanting.** The significance of soil inoculum in replanted vineyards is

poorly understood. Soil infection of newly planted vines can occur if sufficient amounts of the pathogen are present.

Ongoing research is focusing on developing a biological control agent for "immunizing" vines against crown gall disease. This would provide protection for clean nursery stock being planted into sites with a past history of crown gall disease. However, at present, no biological agents are commercially available to protect nursery stock against this disease.

## Relative Disease Susceptibilities

Table 9-4, *Relative Disease Susceptibilities*, provides a relative rating of grape variety susceptibility based on observations in Ontario and northeast United States under average conditions. Under adverse weather conditions, for example, extended cool weather, any given variety may be more seriously affected.

TABLE 9-4. Relative Disease Susceptibilities

Blank = relative susceptibility is unknown  
+ = slight susceptibility  
++ = moderate susceptibility  
+++ = highly susceptible

1 = Sulphur sensitive  
2 = Dikar + Zolone combination may be phytotoxic  
3 = Dikar sensitive  
4 = Thiodan sensitive  
5 = Copper sensitive

Cultivar	Type <sup>a</sup>	Eutypa dead arm	Phomopsis cane blight	Black rot <sup>b</sup>	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity <sup>c</sup>
<b>Vinifera Wine</b>								
Auxerrois	V		++		+	+++	+++	
Cabernet Franc	V		++	+++	++	+++	+	
Cab. Sauvignon	V	++	++	+++	++	+++	+	
Chardonnay	V	+	++	+++	++	+++	++	3
Gamay	V	+	+	+	++	+++	++	
Gewurztraminer	V	++		+++	++	+++	+++	
Kerner	V				+++	++	+	
Merlot	V		+	++	++	+++	+	5
Pinot Blanc	V			+++	++	+++	+++	
Pinot Gris	V			+++	++	+++	+++	
Pinot Noir	V			+++	++	+++	+++	
Riesling	V	+	+	+++	++	+++	+++	
Sauvignon Blanc	V			++	++	++	++	5
Scheurebe	V				+	+++	+	
Zweigeltrebe	V		++	+++	++	+++	+	
<sup>a</sup> = Species type <sup>b</sup> = Black rot is more serious adjacent to bush or similar areas with poor air drainage. <sup>c</sup> = These notes are based on grower experience and could vary under stress conditions.								
<sup>L</sup> = labrusca <sup>AH</sup> = American hybrids <sup>FH</sup> = French hybrids <sup>V</sup> = Vinifera (All vinifera varieties not included in this chart should be considered powdery mildew susceptible.)								

TABLE 9-4. Relative Disease Susceptibilities (cont'd)

Blank = relative susceptibility is unknown

+ = slight susceptibility

++ = moderate susceptibility

+++ = highly susceptible

1 = Sulphur sensitive

2 = Dikar + Zolone combination may be phytotoxic

3 = Dikar sensitive

4 = Thiodan sensitive

5 = Copper sensitive

Cultivar	Type <sup>a</sup>	Eutypa dead arm	Phomopsis cane blight	Black rot <sup>b</sup>	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity <sup>c</sup>
<b>Hybrid Wine</b>								
Baco Noir	FH		++	+	+	++	+	4
Chambourcin	FH		+	++	++	++	+	1,4
Chancellor	FH		+	+	+++	+++	++	5
Chelois	FH	+++	++	++	+	+++	++	3
Couderc Muscat	FH			++		+++	+	
De Chaunac	FH	+	+++	+	+	++	+	1
Foch	FH	++	++	+	+	++	+	1,2,3
J.S.23-416	FH		+			++		
Rosette	FH		++	++	+	+++	+	
Seyval Blanc	FH		++	++	++	+++	+++	
S.V. 23-512	FH		+			++		
Vidal 256	FH		+	+	++	++	+	5
Ventura	AH	++	++	++	++	++		
Villard Noir	FH		+			++		3, 4
<b>Juice &amp; Table</b>								
Agawam	L	+	++	+++	+++	++		
Canadice	AH			+++	+	+	++	
Concord	L	+	++	++	++	++	+	1,4,5
Elvira	L	+++	+++	++	+	++	++	5
Festivee	AH				+	+++	++	
Fredonia	L	+	++	++	+++	++	+	
Himrod	AH		+	++	+	++		
N.Y. Muscat	L	+		+	+	++	+	
Niagara	L	++	++	+++	+++	++	+	5
Sov. Coronation	L		+			+		
Van Buren	L	+			+++	++		1
Vanessa	AH		+	+++	++	++	+	

a = Species type

b = Black rot is more serious adjacent to bush or similar areas with poor air drainage.

c = These notes are based on grower experience and could vary under stress conditions.

L = labrusca

AH = American hybrids

FH = French hybrids

V = Vinifera (All vinifera varieties not included in this chart should be considered powdery mildew susceptible.)

**TABLE 9-5. Effect of Fungicides on Grape Diseases\***

0 = ineffective  
 + = slightly effective  
 ++ = moderately effective  
 +++ = very effective  
 ( ) = numbers of day from last spray to harvest

Fungicide	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot
Folpan (1 day)	+++	++	+++	++	+
Captan (7 days)	+++	++	+++	0	+
Dikar (30 days)	+	+++	+++	+++	0
Dithane M-45 (30 days)	+	+++	+++	0	0
Manzate 200 (30 days)	+	+++	+++	0	0
Ferbam (7 days)	+	+++	++	0	0
Sulphur (21 days wine, 1 day table)	0	0	0	+++	0
Kumulus DF (21 days wine, 1 day table)	0	0	0	+++	0
Benlate (7 days)	+	++	0	+++	0
Rovral (7 days)	0	0	0	+	+++
Elevate (7 days)	0	0	0	0	+++
Vangard (7 days)	0	0	0	0	+++
Copper-Lime (30 days wine)	+	++	++	++	0
Polyram (45 days)	?	+++	+++	0	0
Nova (21 days)	0	+++	0	+++	0
Ridomil Gold MZ (prebloom only)	?	?	+++	?	?
Ridomil-Copper plus Lime (66 days)	?	?	+++	?	?

\* Use fungicides only for diseases listed on the product label.

Visit the grape page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/hort/grape.html>

# 10. Tender Fruit

## (Stone Fruit and Pears)

### Tender Fruit Nutrition

#### Fertilizer for Tender Fruits (Stone Fruit and Pears)

Soil preparation and soil testing before planting trees is important. Well in advance of planting; prepare the soil through tillage and additions of organic matter, to ensure long term productivity of these perennial crops. For information on building and maintaining soil organic matter see *Managing Soil Organic Matter* on page 20 and *Manure for Orchards*, below.

Prior to planting, ensure that nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to *Fertilizer for Non-Bearing Tender Fruit*, page 115. Phosphorus, potassium and lime, do not move readily through the soil and pre-plant applications are the most effective.

#### Manure for Orchards

A spring application of manure can be beneficial in providing nutrients and organic matter to established orchards. It is better to add manure to cultivated orchards compared to those in permanent sod since the manure can be easily worked into the soil, making it available to the tree roots. You can also apply manure in the fall to provide nutrients and organic matter prior to new spring plantings.

Broadcast manure at no more than 7 tonnes/ha of poultry manure (20 m<sup>3</sup> liquid), 40 t/ha of cattle (100 m<sup>3</sup> liquid), or 35 t/ha hog (65 m<sup>3</sup> liquid). Manure is extremely variable in nutrient content and should be analyzed before application. When using manure, reduce the rate of fertilizer. Table 3-5, page 21, shows the average composition of some manures and suggested reduction in fertilizer if using manure.

Nitrogen in manure can be released over a prolonged time. Perennial crops that have manure applied continue to be supplied with nitrogen during the year. This can be a disadvantage, resulting in:

- poor fruit colour
- excessive terminal growth
- delayed hardening of the woody tissue
- increased susceptibility to winter injury.

Placing manure around newly planted trees is not recommended because of potential winter injury problems.

#### pH Requirements for Tender Fruit

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. Taking a soil sample will determine its pH. For information on soil sampling, consult *Soil Testing* on page 15.

Always take a soil sample before establishing a new planting. If lime is required, incorporate it during soil preparation. In established orchards, a soil sample in the tree row is recommended every 3 years to ensure that the pH is at a satisfactory level. If pH is low (acidic), lime can be applied to the sod cover in the fall, or before cultivation in the spring. The results will not be immediately evident because the lime moves slowly into the soil.

The preferred pH before establishing a new orchard is 6.5 on sandy soils and 6.0 on clay soils. If the pH in established orchards is above 5.6, lime is not needed. Apply lime to established orchards when the pH on clay loam soils drops below 5.1, and on sandy soils below 5.6. Applying lime to a soil reduces its acidity by raising the pH. It also supplies calcium. Use dolomitic lime (high in magnesium) on soils



**TABLE 10-1. Nutrient Level Range (% Dry Weight) of Mid-Shoot Leaves  
(taken the last 2 weeks of July from mature trees)**

Leaf Analysis	Nitrogen*		Potassium		Magnesium
	Low if below	High if above	Low if below	High if above	Low if below
PEACH	3.4	4.1	2.3	3.5	0.35
PEAR	2.0	2.6	1.2	2.0	0.25
CHERRY Montmorency	2.2	3.0	1.3	2.5	0.35

\* Leaf nitrogen in non-bearing trees should be 0.2% higher

low in magnesium. Rates of application will vary with soil type and initial pH. The buffer pH determines the rate of lime to apply. For information on lime, consult *Soil Acidity And Liming* on page 18.

## Leaf Analysis for Tender Fruit

In established plantings, leaf analysis for tender fruit is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests consult *Plant Analysis* on page 17.

Nutrient uptake is affected by many orchard conditions. Consequently, each year the nutrient levels vary slightly depending upon the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the leaves and the relative amounts must be balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. For nutrient ranges of pears, peaches and tart cherries leaf analysis, consult Table 10-1, *Nutrient Level Range of Mid-Shoot Leaves*.

Fertilizer requirements are adjusted to the system of soil management, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size and colour and storage quality, must also be considered in determining the fertilizer required.

## Fertilizer for Tender Fruit

### Fertilizer for Non-Bearing Tender Fruit

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Nutrient levels in the topsoil considered to be adequate for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium, and 1000–5000 ppm calcium. Table 10-2, *Phosphorus and Potassium Requirements for Tree Fruits*, provides information on fertilizer rates prior to planting.

If the soil has been prepared properly, including deep cultivation and addition of organic matter, there should be an adequate supply of other nutrients to sustain the tree in the juvenile years. On coarse-textured, infertile soils, the use of a starter solution at planting time (e.g., 10–52–10 or 20–20–20) may give the trees a needed boost. High nitrogen levels can result in excessive growth and incomplete tree hardening. The use of cover crops to check late season growth in cultivated orchards is strongly recommended, especially in new plantings. Cover crops such as Italian rye grass, sown about July 1, take up much of the available nitrogen in the soil — checking tree growth.

On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can occur if placed too close.

**TABLE 10-2. Phosphorus & Potassium Soil Requirements before Planting Tender Fruits**

Soil Phosphorus		New plantings of peaches, pears, plums, cherries*	Soil Potassium		New plantings of peaches, pears, plums, cherries*
Soil Test (ppm P)	Phosphate (P <sub>2</sub> O <sub>5</sub> ) req'd kg/ha		Soil Test (ppm K)	Potash (K <sub>2</sub> O) req'd kg/ha	
0-3	80 L		0-15	180 L	
4-5	60 L		16-30	170 L	
6-7	50 L		31-45	160 L	
8-9	40 M		46-60	140 L	
10-12	20 M		61-80	110 L	
13-15	0 H		81-100	70 M	
16-20	0 H		101-120	40 M	
21-25	0 VH		121-150	20 M	
26-30	0 VH		151-180	0 H	
31-40	0 VH		181-210	0 H	
41-50	0 VH		211-250	0 VH	
51-60	0 VH		250 +	0 E	
61-80	0 E				
80 +	0 E				

\* For established tree fruits, plant analysis is used to estimate requirements of N, P + K

### Fertilizer for Bearing Tender Fruit

Most bearing orchards require annual applications of both nitrogen and potassium fertilizer. These 2 elements have very significant effects on growth and productivity.

It is important not to apply nitrogen in excessive amounts. Late or excessive applications of nitrogen may result in poor fruit colour and quality. Also, available nitrogen late in the season encourages the tree to grow instead of hardening off, resulting in a potential for winter injury.

Using cover crops in cultivated orchards helps to lower the nitrogen level in the latter part of the season. Cover crops such as Italian rye grass, sown about July 1, take up much of the available nitrogen in the soil, thus checking tree growth. In herbicide-treated strips under trees, weed growth late in the season takes up extra nitrogen, helping to harden off trees and improve fruit quality.

### Nitrogen (N)

Nitrogen is necessary for many tree functions including growth, fruit bud formation, fruit set and fruit size. Cultivars differ in their nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also affect application rates. If pruning is to be

severe, cut nitrogen rates back or eliminate it for a year. Tree growth, foliage colour, and fruit colour, quality and storability, nutrient balance in leaves and soil, are also important considerations. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Do not apply urea (46-0-0) to sod orchards since some of the nitrogen may be lost by volatilization. There are several forms of nitrogen available. If there has been fruit bud damage because of severe winter temperatures, it may be necessary to split applications. Apply the first application in mid April and the second, if necessary, after bloom in late May. Excessive spring rains can leach away spring-applied nitrogen. Apply additional fertilizer or foliar sprays after bloom. During dry springs, you may have to irrigate to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall.

Suggested maximum rates of actual N should be lowered for fire blight sensitive pear cultivars.

For pear, peach, plum, and cherry orchards where leaf analysis is not available, the following rates could be considered normal.

For each year of tree's age, apply between 30 and 40 g of N. Thus, a 5-year-old tree in sod culture requires 150-200 g of N. See Table 10-3, *Actual Nitrogen Rates Per Tree in Sod Culture*. The rate for cultivated orchards can be cut by half, as competition for nutrients is greatly reduced. Trees on dwarfing rootstock generally require more nitrogen per hectare (not per tree) than trees on more vigorous stocks. When the tree canopy has covered the space available, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.

For all tree fruits do not exceed the maximum rates of 200 kg actual N/ha per year, even in the case of a severe deficiency.

### Nitrogen Placement and Timing

Apply nitrogen fertilizer in early April. In cultivated orchards broadcast nitrogen under the tree canopy. In sod orchards place the nitrogen in a band under the drip line or in the herbicide strip.

### Foliar Application of Nitrogen for Tender Fruit

Foliar applications of urea (46% nitrogen) have been used successfully on apples, when weather or crop conditions resulted in a need for additional nitrogen at a critical time. Late applications may adversely affect fruit quality and

**TABLE 10-3. Actual Nitrogen Rates Per Tree in Sod Culture**

YEAR or TREE AGE	ACTUAL NITROGEN per TREE (grams)		
	Number of Trees/Ha (trees/ac)		
	400 (160)	500 (200)	600 (240)
Planting Yr	0	0	0
1	40	40	40
2	80	80	80
3	120	120	120
4	160	160	160
5	200	200	180
6	240	240	240
7	280	280	260
8	320	320	280
9	360	360	300
10	400	400	320
11	440	400	320
12	480	400	320

winter survival of the tree. Do not rely on foliar sprays to completely substitute for soil applications if nitrogen is required. There are several formulations of foliar N. In some years, make applications based on tree performance and leaf analysis.

### Phosphorus (P)

Phosphorus is not required in large amounts by fruit trees. With few exceptions the level of phosphorus in Ontario soils is adequate at present without additional being required. Phosphorus does have a place for sod or cover crop maintenance. A soil test is the best way to determine if you need to apply this nutrient to the sod cover. In the absence of a soil test, a complete fertilizer (100 kg/ha 10-20-20) could be broadcast and incorporated before seeding a cover crop in an orchard. If indicated by a soil test, you should apply phosphorus before planting an orchard when it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12-20 ppm are considered adequate for tree fruit establishment and production.

### Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance (fire blight in pears). An excess amount of potassium can lead to deficiency of magnesium (Mg), so take care when deciding upon potassium rates. Potassium soil test values between 120-150 ppm are considered adequate when planting tree fruits. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available the following rates can be considered normal:

#### *Trees 1-6 Years of Age Regardless of Density*

Apply 50 g K<sub>2</sub>O (80 g muriate of potash) per 2.5 cm of trunk cross-section (diameter).

#### *Trees 7 Years of Age or Older*

Apply no more than 3 kg of K<sub>2</sub>O (5 kg muriate of potash) per mature standard tree in a year, regardless of how severe the deficiency. When the tree canopy has covered the space available, potassium fertilizer requirements will level out and will not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.

#### *Placement and Timing*

You can apply potassium separately or combined with nitrogen in early spring. Some growers make fall applications because of time constraints in the spring. However, some of the potassium may be lost by leaching over winter. For this reason, apply in spring, if possible. In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

#### *Foliar Application of Potassium for Tender Fruit*

In dry growing seasons potassium is not readily available to the plant. Where a potassium deficiency has been confirmed foliar applications of potassium may help.

### Magnesium (Mg)

Magnesium deficiency is becoming more evident in orchards, particularly when high rates of potash are used.

Magnesium deficiency can lead to premature drop of fruit at harvest. Magnesium deficient trees have older leaves that

**TABLE 10-4. Magnesium Foliar Sprays**

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1000 L water	Wet tree to point of run-off. Do not concentrate beyond 40 kg/1000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

\* Use chelates recommended for foliar sprays.

are pale in colour, as magnesium is a part of the chlorophyll molecule. Leaf analysis is the best way to evaluate Mg needs.

Foliar sprays of magnesium have been effective in correcting this deficiency for the current year only. For more permanent correction, soil applications of Mg are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting tree fruits. See Table 10-4, *Magnesium Foliar Sprays*.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate; therefore, apply magnesium sulfate separately or try it on a few trees first. Check manufacturer's label regarding mixing magnesium chelates<sup>1</sup> with pesticides.

For long-term corrections, soil application of Mg can be made, but the response will not likely be immediate. Also, on some soil types a single early spring application of soil applied Mg has not worked well. A second or third application the following spring may be required before the Mg level in the tree improves. To be sure that fruit drop is not a problem during this waiting period, foliar sprays are recommended for the first 2 years, in addition to soil applications.

For soil corrections, apply 5–7 kg/mature standard tree, and 3–4 kg/mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer known by several trade names. It contains approximately 21% potash and 11% magnesium. This material is applied in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. No further potash (e.g. 0–0–60) is needed, but apply nitrogen at recommended rates. Other sources of Mg may also work well as a soil application. If Mg is being blended with the fertilizer, apply at least 80 kg of available Mg per hectare when the fertilizer is spread. Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply Mg.

### Calcium (Ca)

Lack of calcium is associated with fruit problems in pear, and gummosis in European plums and prunes. Some formulations of calcium chloride ( $\text{CaCl}_2$ ) have resulted in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective; therefore water volumes capable of wetting the entire tree are required. The more calcium applied, the better the control, however excessive calcium can cause foliar burning. Use  $\text{CaCl}_2$  (77% flakes) at 4 kg/1000 L of water from early

July to mid-Aug. Apply 3 sprays, 10–12 days apart. Do not apply Ca formulations containing nitrogen after the end of July or fruit quality and storability may suffer.

For all the formulations, be sure to consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual Ca is often required in a total of 4 or more sprays. Ca sprays may injure foliage and fruit if applied during low temperature and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

## Micronutrients for Tender Fruit

Deficiencies of micronutrients or trace elements are not wide spread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Only the nutrient that is deficient should be applied in sufficient quantities to correct the problem.

### Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency can have an effect on growth and fruiting.

There is currently no accredited soil test for boron in Ontario. Use a foliar analysis to check for boron deficiencies. Boron levels should be 20–60 ppm. Where a boron deficiency has been confirmed, soil or foliar applications of boron may improve boron in plant tissues. There are several sources of boron. Check the manufacturer's recommended rates and timing of applications.

### Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, use soil tests to determine the status of manganese in the soil. Soil manganese index values greater than 8 should provide adequate

1. Use chelates recommended for foliar sprays.



manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate.<sup>1</sup> Use manganese sulphate with a spreader sticker. Soil applications of manganese are not effective. Consult manufacturer's label for complete information on rates and timing.

### **Manganese toxicity**

On some peach cultivars manganese toxicity can occur on coarse-textured soils when the soil is very acid (pH below 5.0). The symptoms known as "measles" are raised pimples on the bark underlain by dark brown spots. Other symptoms that may be observed are leaf chlorosis, tip dieback, early leaf abscission, reduced flower bud development and shoot growth. Correction is sometimes possible by adding lime to raise the soil pH. If possible, work it into the soil. Soil sampling and addition of lime if pH is low is recommended prior to orchard planting.

### **Iron (Fe)**

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of

new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the tree is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a foliar analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates<sup>1</sup> have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

### **Zinc (Zn)**

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to leaf analysis, soil tests can be used to determine the status of zinc in the soil. A soil zinc index value greater than 8 should provide adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

**Warning: Do Not Concentrate Nutrient Sprays**

<sup>1</sup> Use chelates recommended for foliar sprays.



# Stone Fruit Fungicides Notes

## Brown Rot Control

### Development of Resistance

Benlate, Senator, and a formerly marketed product called Esasout, are chemically-related fungicides. These products gave superior control of brown rot in the past. Frequent and sometimes almost exclusive use of Benlate in the 1970's resulted in the selection of Benlate (benomyl)-resistant forms of the brown rot fungus in many stone fruit orchards in the Niagara region. This type of resistance has remained quite stable in the field for the last 20 years.

Benlate is recommended only as a tank-mixture with Captan in areas where resistance is not prevalent (e.g. possibly Essex, Kent). Captan will provide some insurance against losses associated with the development of Benlate resistance. Benlate-Captan must not be used in orchards known to have Benlate-resistant strains of the fungus because Benlate would be largely ineffective, and the reduced rate of Captan would not be sufficient to give adequate protection by itself.

Rovral gives superior control of brown rot on cherries and peaches. Rovral has some post-infection activity and also reduces new spore production on established lesions. Because Rovral-resistant forms of the brown rot fungus can be easily selected in the laboratory, resistance could occur also in the orchard. Rovral-resistant forms of brown rot have been found in the field in New Zealand but not in recent surveys conducted in Ontario (1995-96).

Vanguard is a new Novartis Crop Protection product registered in North America in 1998. It has been registered for use in Europe for 2 years on grapes for Botrytis bunch rot and brown rot on stone fruit. Botrytis has already developed resistance to this product in Europe and the risk of resistance developing is expected to be similarly high for brown rot. Therefore take extreme caution not to overuse this new product. Limit use of Vanguard to 2 applications per season, and never use in consecutive or back-to-back sprays.

### Management of Resistance

Limit Rovral to only 1-2 applications per season, to delay the possible development of brown rot resistance to Rovral and cross-resistance to Botran and Ronalin. Apply Rovral when the crop is most susceptible to infection, such as at bloom and immediately pre-harvest, and use less effective materials when there is reduced risk of infection. Alternate Rovral with other fungicides to minimize resistance development.

Bravo, Sulfur and Captan are protective fungicides. Brown rot has not developed resistance to these products. Sulfur is not widely recommended. Sulfur can irritate the skin of persons harvesting fruit, and it kills beneficial mites, resulting in outbreaks of red mite. Captan is particularly valuable in programs designed to delay the development of fungicide resistance. It is registered for use as a tank mixture with Benlate. Alternate Captan with other fungicides, so you can use resistance-prone fungicides, such as Rovral less frequently. A disadvantage of Captan is its phytotoxicity to a few sweet cherry cultivars (e.g., Schmidt), Stanley prune, and Japanese plums.

To date there have been no documented cases of resistance to the new group of demethylation (DMI) fungicides, Topas, Funginex and Nova. In a few peach orchards in South Carolina where Topas (Orbit) has been used exclusively for 7-10 years, preliminary observations suggest reduced sensitivity of brown rot isolates. This has not resulted in field control failures to date.

In order to manage resistance it is important to:

- minimize the number of applications per season per chemical group (see Table 10-5, *Chemical Families of Fungicides*)
- rotate between different chemical families (see Table 10-5)
- apply fungicides before an infection period, not as a clean-up spray after an infection has occurred.

TABLE 10-5. Chemical Families of Fungicides

Chemical Family	Brand Name Products	Risk of Resistance—mode of action	Restrict Number of Applications** Per Season to Slow Development of Resistance
Benzimidazoles	Benlate, Easout, Topsin	high – single site	high level of resistance; no longer recommended (if no resistance 2 applications per season)
Phthalimide	Captan	low – multiple site	number of maximum applications has not been set
Dicarboximides	Rovral, Ronalin, Botran	moderate – single site	1–2 applications per season
Demethylation Inhibitors	Funginex, Nova, Topas	moderate – multiple gene mediated	2–3 applications per season
Hydroxylanilide*		high – single site	2–3 applications per season
Chloronitrile	Bravo	low – multiple site	number of maximum applications has not been set
Strobilurins*		high – single site and multi-step	2 applications per season
Anilinopyrimidines	Vanguard	high – single site	2 applications per season; do not use in consecutive or back to back sprays.
Inorganic	Sulfur	low – multiple site	number of maximum applications has not been set

\* not registered in Canada

\*\* restrictions based on label and/or scientific literature

TABLE 10-6. Effect and Activity of Fungicides on Stone Fruit Diseases\*

Brand Name	Brown Rot Blossom Blight	Brown Rot Fruit Phase	Period of Effective Activity for Brown Rot	Rhizopus Rot	Cherry Leaf Spot	Powdery Mildew	Black Knot	Peach Leaf Curl	Registered for Use on:			
									Apricot	Sweet Cherry	Peaches Nectarines	Plum
Bravo	+++	X	3-5 days	?	++++	0	++++	++++		✓	✓	
Captan/Maestro	+++	+++	3 days	0	+++	0	+++	X	✓	✓	✓	✓
Clean Crop Copper 53W	X	X	X	?	+++	++	X	++-+++			✓	
Ferbam	0	0	0	?	++	0	0	++++			✓	
Funginex	+++	X	3-4 days	?	+++	+++	?	0		✓	✓	✓
Topas	++++	++++	5-7 days	++	+++	+++	++	X	✓	✓	✓	✓
Nova	+++ - ++++	X	3-5 days	0	+++	++++	?	X		✓	✓	✓
Rovral	++++	++++	7 days	++++	++	?	0	X	✓	✓	✓	✓
Sulfur	++	+	3 days	0	+	++	+-++	X		✓	✓	✓
Vanguard	+++	+++	3-5 days	+	?	0	?	X	✓		✓	✓

Registration Status Legend: ✓ - registered on crop  
 \* Use fungicides only for diseases listed on the product label.

X - not recommended or does not apply

0 - not effective

+- slight

++ - fair

+++ - good

++++ - very good

+++++ - excellent

? - unknown

# Apricot Calendar

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide for Spraying Tree Fruits on page 12.

Diseases & Insects	Materials	Amount per 1000 L	Amount per hectare	Comments
<b>Dormant (In late March or early April before buds swell)</b>				
European red mite	Superior Oil (see notes)	20 L	60 L	Rate per 1000 L is based on 11.4 to 13.6 L of spray per mature tree.
<b>Prebloom (When blossom buds show pink)</b>				
Brown rot	• Rovral 50 WP	0.50 kg	1.50 kg	Apricots are extremely susceptible to brown rot at blossom time and just before picking. <b>Do not apply Rovral or Vanguard more than 2 times for each product per season.</b> Alternate between fungicides and do not use the same product in consecutive sprays. See note on resistance management of brown rot fungicides, page 120. The addition of Benlate 50 WP at 850 g/ha to Captan 50 WP at 4 kg/ha will improve brown rot control only where the fungus is not resistant to Benlate. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
Blossom blight	• Captan 50 WP	2.00 kg	6.00 kg	
	or Captan 80 WP	1.25 kg	3.75 kg	
	or Maestro 75 DF	1.30 kg	4.00 kg	
	• <sup>4</sup> Vanguard 75 WG	123 g	370 g	
	• <sup>5</sup> Topas 250 EC	165 mL	500 mL	
<b>Do not apply insecticides while apricot trees are in bloom. See Bee Poisoning on page 41.</b>				
<b>Shuck Split (When about 50% of shucks have split)</b>				
Brown rot	• Rovral 50 WP	0.50 kg	1.50 kg	Apricots are extremely susceptible to brown rot. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Captan 50 WP	2.00 kg	6.00 kg	
	or Captan 80 WP	1.25 kg	3.75 kg	
	or Maestro 75 DF	1.30 kg	4.00 kg	
	• <sup>4</sup> Vanguard 75 WG	245 g	740 g	
	• <sup>5</sup> Topas 250 EC	165 mL	500 mL	
Plum curculio	• <sup>4</sup> Guthion 50 WP	625 g	2.00 kg	<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>6</sup> Minimum period for reentry is 7 days. See product label for specific reentry requirements and precautions.
	or <sup>4</sup> Guthion Solupak 50 WP	625 g	2.00 kg	
	or <sup>4</sup> Sniper 50 W	775 g	2.30 kg	
	• <sup>6</sup> Parathion 15 WP	1.50 g	4.50 kg	
	• Sevin XLR Plus	750 mL	2.30 L	
<b>Shuck Fall (10 to 12 days after last spray)</b>				
Brown rot	Use same materials as for <b>Shuck Split</b>		For peach tree borer, refer to treatment as for peaches. See page 131.	
Plum curculio				
<b>First Cover (10 to 12 days after Shuck Fall)</b>				
Brown rot	Use one of the fungicides listed under <b>Shuck Split</b> .			
Plum curculio	Use one of the insecticides listed for plum curculio at <b>Shuck Split</b> .			
<b>Special Sprays</b>				
European red mite	• Kelthane 50 W	1.10 kg	3.25 kg	European red mite is a sporadic pest and is rarely a problem in apricot orchards. Apply when mites build up to 10 active stages per leaf.
<b>Pre-Pick Harvest</b>				
Brown rot	Use one of the fungicides listed under <b>Shuck Split</b> .		Apricots are extremely susceptible to brown rot just before picking. Additional sprays may be required during harvest if conditions are wet.	

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## Disease Control

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### Verticillium wilt

Do not plant apricots following tomatoes, strawberries, potatoes, eggplants or peppers. Also do not interplant with these crops.

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### Bacterial spot

There is no satisfactory chemical control for bacterial spot during the cropping season. The use of fixed copper sprays when trees are dormant can lower overwintering bacterial levels, and delay the progress of disease on leaves and fruit.

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## Insect Control

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### Oblique-banded Leafroller

Oblique-banded leafroller can be a serious problem on apricot. Controlling leafroller populations in surrounding crops such as sweet cherry, apple and pear can reduce pest pressure.

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### Oriental Fruit Moth

Oriental fruit moth (OFM) can migrate from peach and nectarine blocks and become a serious problem in apricots. Pre-pick sprays are essential to avoid invisible OFM injury.

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### Peach Tree Borers

Lesser peach tree borer and peach tree borer can be serious problems in apricot blocks. Redirect a nozzle when spraying insecticides for plum curculio and preharvest cover sprays. This provides spray coverage of the trunks and lower scaffolds.

Visit the tree fruit page on the OMAFRA web site at  
[http://www.gov.on.ca/OMAFRA/english/crops/hort/tree\\_fruit.html](http://www.gov.on.ca/OMAFRA/english/crops/hort/tree_fruit.html)



# Sour Cherry Calendar

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide for Spraying Tree Fruits on page 12.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Prebloom</b>			
European red mite	• Superior Oil	60 L	Only needed in sour cherry orchards with a heavy mite population. Spray as buds are breaking. Apply oil in 3000 L/ha (dilute rate).
<b>Bloom</b>			
Do not apply insecticides while cherry trees are in bloom. See Bee Poisoning on page 41.			
Brown rot (stem rot and blossom blight stages)	<ul style="list-style-type: none"> <li>• Nova 40 W</li> <li>• Rovral 50 WP</li> <li>• <sup>4</sup>Bravo 500</li> <li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>• Funginex 190 EC</li> <li>• Sulphur 92 WP</li> <li>• <sup>5</sup>Topas 250 EC</li> </ul>	<ul style="list-style-type: none"> <li>340 g</li> <li>1.50 kg</li> <li>7.00 L</li> <li>7.50 kg</li> <li>4.50 kg</li> <li>2.50 kg</li> <li>19.50 kg</li> <li>500 mL</li> </ul>	<p>Spray just before blooms open if weather conditions are expected to be wet and warm (above 16°C) during bloom. Sour cherries are less susceptible to brown rot compared to sweet cherries. One application during bloom should be sufficient unless frequent wet periods occur and brown rot pressure is high. Do not use Captan or Maestro within 14 days following an oil application.</p> <p>Nova is most effective when applied as a protectant fungicide prior to an infection or wetting period. Nova and Topas are absorbed by flower parts making this material more rain-fast than other protectant fungicides. Do not use Rovral more than 2 times per season and never in consecutive sprays. See <i>Brown Rot Control</i>, page 120. Rovral is only necessary under high disease pressure.</p> <p>Do not apply Bravo 500 within 10 days of an oil application, as it will cause burning to flower and leaf tissue.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p> <p><sup>5</sup>Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.</p>
<b>Petal Fall</b>			
Leaf spot	<ul style="list-style-type: none"> <li>• <sup>4</sup>Bravo 500</li> <li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>• Nova 40 W</li> <li>• Benlate 50 WP plus Captan 50 WP</li> <li>• Ferbam 76 WDG</li> <li>• Equal 65 WP</li> </ul>	<ul style="list-style-type: none"> <li>7.00 L</li> <li>7.50 kg</li> <li>4.50 kg</li> <li>4.75 kg</li> <li>340 g</li> <li>850 g</li> <li>3.50 kg</li> <li>6.00 kg</li> <li>2.25 kg</li> </ul>	<p>Spray only if rain is forecast between <b>Bloom</b> and <b>Shuck</b> sprays. Make no more than 4 applications of Nova per season. Apply 1 application of Bravo 500 to control early season leaf spot. After <b>Shuck Split</b> rotate with other products as a resistance management strategy.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p>
Black knot	• <sup>4</sup> Bravo 500	7.00 L	<p>This spray is only required on sour cherry orchards with a history of this disease. Prune out, remove and burn all black knots from commercial orchards during the dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. Do not apply Bravo 500 after <b>Shuck Split</b> to avoid fruit injury.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p>
<b>Shuck</b>			
Plum curculio	<ul style="list-style-type: none"> <li>• <sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li> <li>• Zolone Flo</li> <li>• Imidan 50 WP</li> </ul>	<ul style="list-style-type: none"> <li>2.00 kg</li> <li>2.00 kg</li> <li>2.30 kg</li> <li>2.00 L</li> <li>3.75 kg</li> </ul>	<p>Spray when most of the shucks are off and plum curculio activity is observed. Zolone also helps control aphids. Make no more than 3 applications of Zolone Flo per season.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p>
Brown rot	<ul style="list-style-type: none"> <li>• <sup>4</sup>Bravo 500</li> <li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>• Rovral 50 WP</li> <li>• <sup>5</sup>Topas 250 EC</li> </ul>	<ul style="list-style-type: none"> <li>7.00 L</li> <li>7.50 kg</li> <li>4.50 kg</li> <li>4.75 kg</li> <li>1.50 kg</li> <li>500 mL</li> </ul>	<p>Do not apply Rovral more than 1 or 2 times per season, and never in consecutive sprays. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.</p> <p><sup>4</sup>Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p> <p><sup>5</sup>Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.</p>

Diseases and Insects	Materials	Amount per Hectare	Comments
Leaf spot	Use one of the fungicides recommended at <b>Petal Fall</b> with the exception of Ferbam.		
European red mite	• Kelthane 50 W	3.25 kg	Thorough coverage is necessary for good mite control. Only needed in heavily infested sour cherry orchards.
Black knot	• <sup>4</sup> Bravo 500	7.00 L	<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>First Cover (12 days after Shuck)</b>			
Plum curculio	Use one of the insecticides listed under <b>Shuck</b> .		Monitor 7 days after shuck fall insecticide for new plum curculio damage. If crescent shape cuts on fruit are found, then apply an insecticide. Zolone helps control aphids.
Leaf spot	Use one of the fungicides listed under <b>Petal Fall</b> with the exception of Ferbam.		
<b>Second Cover (12 days after First Cover)</b>			
Cherry fruit fly	• <sup>4</sup> Guthion 50 WP	2.00 kg	On early varieties, check interval from last spray to harvest date. Spray when early varieties are beginning to colour. Diazinon does not adequately control plum curculio. Zolone provides 12–14 days protection against cherry fruit fly while Diazinon provides 10 days. Make no more than 3 applications of Zolone Flo per season. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Plum curculio	or <sup>4</sup> APM 50 W	2.00 kg	
	or <sup>4</sup> Sniper 50 W	2.30 kg	
	• Diazinon 50 W	3.00 kg	
	• Zolone Flo	2.00 L	
	• Imidan 50 WP	3.75 kg	
Leaf spot	Use one of the fungicides as recommended at <b>Petal Fall</b> with the exception of Ferbam.		
Powdery mildew	• Nova 40 W	340 g	Make no more than 4 applications of Nova per season. Sulphur at this rate will suppress powdery mildew. Higher rates may cause injury.
	• Benlate 50 WP	1.75 kg	
	• Sulphur 92 WP	10.00 kg	
<b>Third Cover</b>			
Cherry fruit fly	• Sevin XLR Plus	2.30 L	Spray sour cherries about the time Montmorency is turning pink. Sevin provides 5–7 days protection. Make no more than 3 applications of Zolone Flo per season.
	• Imidan 50 WP	3.75 kg	
	• Zolone Flo	2.00 L	
	• Diazinon 50 W	3.00 kg	
Leaf spot	Add one of the fungicides listed under <b>Petal Fall</b> with the exception of Ferbam.		
<b>Preharvest</b>			
Brown rot	Add one of the fungicides listed under <b>Petal Fall</b> . The addition of Benlate 50 WP at 850 g/ha to Captan 50 WP at 3.50 kg/ha will improve brown rot control only where the fungus is not resistant to Benlate.		
<b>Post Harvest</b>			
Leaf spot	• <sup>4</sup> Bravo 500	7.00 L	Necessary where leaf spot is a problem. Make no more than 4 applications of Nova per season.
	• Captan 50 WP	7.50 kg	
	or Captan 80 WP	4.50 kg	
	or Maestro 75 DF	4.75 kg	<sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
	• Nova 40 W	340 g	
	• Ferbam 76 WDG	6.00 kg	
	• Benlate 50 WP	850 g	
	plus Captan 50 WP	3.50 kg	
	• Equal 65 WP	2.25 kg	
Powdery mildew	• Benlate 50 WP	1.10 kg	
European red mite	• Kelthane 50 W	3.25 kg	If mites can easily be found on the leaves at this time, add a miticide with your fungicide application.
<b>Special Sprays</b>			
Aphids	• Diazinon 50 W	3.00 kg	These may be added to any of the sprays after bloom. Thorough coverage and a calm, warm day are necessary for good aphid control. Make no more than 3 applications of Zolone Flo per season.
	• Thiodan 50 WP		
	or Endosulfan 50W	3.25 kg	
	• Zolone Flo	2.00 L	
Peach tree borer	• Thiodan 50 WP	1.5 kg/1000L	Apply 3 sprays 3 weeks apart. Apply first spray 10 days after first adult catch in pheromone traps. Direct these sprays with a hand gun to cover the trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the second spray, and do not apply if the fruit is to be harvested during this period.
	• Thionex 50 WP	1.5 kg/1000L	
	• Endosulfan 50W	1.5 kg/1000L	
	• Sevin XLR plus	2.30 L/1000 L	

# Growth Regulator Notes

## Ethephon to Promote Fruit Loosening of Sour Cherries

Ethephon (Ethrel) can be used in sour cherry orchards to promote fruit loosening, uniform maturity, and to facilitate mechanical harvesting.

The effectiveness of Ethrel treatment depends on several factors, particularly ambient temperature and tree vigour. The response time of the tree to Ethrel application increases with higher temperatures and decreases at lower temperatures. For this reason, apply Ethrel only in the temperature range of 18°C–30°C. Remember that hot weather shortens the time needed for response.

Tree vigour also affects the effectiveness of Ethrel treatment. Trees with low vigour, or trees severely stressed by drought, disease or winter injury, and those that had serious gumming the previous year, should not receive Ethrel sprays. Treat only trees which are vigorous and in good health.

Apply ethephon at a rate of 200 ppm ethephon (1 L/1000 L water), 7–10 days prior to anticipated harvest.

This rate provides an adequate response to enhance fruit loosening to facilitate mechanical harvesting. Consult the product manufacturer for further information.

## Cherry Yellows Virus and Use of Gibberellic Acid on Sour Cherry

To moderate early production, apply Gibberellic Acid (GA) at 15 ppm in the fourth year. This will allow flowering in year 5 at a reasonable level rather than allowing heavy bloom and production that may significantly reduce growth in future years.

In mature Montmorency sour cherry trees that are infected with yellow virus, annual applications of GA can help maintain and extend high fruiting capacity and reduce occurrence of blind nodes by stimulating lateral shoots and spurs. Apply about 3 weeks after full bloom. Concentrations of 10–20 ppm are used, with 15 ppm most common. For specific application instructions, consult the product label. Use lower rates on more vigorous trees. Apply at temperatures above 22°C.

# Disease Control

**TABLE 10-7. Cherry Leaf Spot: Approximate Number Of Hours Of Wetting Required For Conidial Infection By The Leaf Spot Fungus At Different Air Temperatures <sup>1</sup>**

Average Temperature (°C)	WETTING PERIOD [hr]		
	Light Infection <sup>2</sup>	Moderate Infection <sup>2</sup>	Heavy Infection <sup>2</sup>
27	25	39	–
25	14	24	36
23	8	17	26
21	6	13	21
17–20	5	12	19
16	6	13	20
13	10	17	24
10	19	27	35
8	25	36	48

<sup>1</sup> Adapted from Eisensmith and Jones, 1981. Plant Disease 65: 955–958 and Phytopathology 71: 728–732.

<sup>2</sup> The infection period starts when rain begins.

## Sweet Cherry Calendar

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide for Spraying Tree Fruits on page 12.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Bloom</b>			
Do not apply insecticides while cherry trees are in-bloom See Bee Poisoning on page 41			
Brown rot (stem rot and blossom blight stages)	<ul style="list-style-type: none"> <li>Nova 40 W</li> <li>Rovral 50 WP</li> <li><sup>4</sup>Bravo 500</li> <li>Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>Funginex 190 EC</li> <li>Sulphur 92 WP</li> <li><sup>5</sup>Topas 250 EC</li> </ul>	340 g 1.75 kg 7.00 L 7.50 kg 4.50 kg 4.75 kg 2.50 kg 19.50 kg 500 mL	Blossom blight is favoured by wet, warm (above 16°C) weather, and especially when large numbers of mummies are present in the trees. Apply first spray just before blossoms open, followed by two additional sprays during the bloom period if weather remains favourable for blight. Do not use Captan or Maestro within 14 days of an application of Superior oil. Do not apply Rovral more than 2 times per season and never in consecutive sprays.  See note on Brown Rot Control on page 120.  Nova is most effective when applied as a protectant fungicide prior to an infection or wetting period. Nova and Topas are absorbed by the flower parts, making this material more rain-fast than other protectant fungicides.  Do not apply Bravo 500 after shuck to avoid fruit injury.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
<b>Petal Fall</b>			
Black cherry aphid	<ul style="list-style-type: none"> <li>Diazinon 50 W</li> <li>Thiodan 50 WP or Endosulfan 50 W</li> <li>Zolone Flo</li> </ul>	3.00 kg 4.50 kg 4.50 kg 2.75 kg	A temperature of at least 21°C, thorough coverage and a calm day are needed for effective aphid control. Usually 1 to 2 sprays are required. Make no more than 3 applications of Zolone Flo per season.
<b>Shuck Fall</b>			
Plum curculio	<ul style="list-style-type: none"> <li><sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li> <li>Zolone Flo</li> </ul>	2.75 kg 2.75 kg 2.30 kg 2.75 L	Spray when most of the shucks are off and plum curculio activity is observed, usually when temperatures are above 16°C. Zolone also helps control aphids. Make no more than 3 applications of Zolone Flo per season.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Brown rot	<ul style="list-style-type: none"> <li>Rovral 50 WP</li> <li>Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>Sulphur 92 WP</li> <li><sup>5</sup>Topas 250 EC</li> </ul>	1.75 kg 7.50 kg 4.50 kg 4.75 kg 19.50 kg 500 mL	Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in post-bloom sprays. Do not apply Rovral more than 2 times/season and never in consecutive sprays.  <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
<b>First Cover (12 days after Shuck Fall)</b>			
Plum curculio	Use one of the insecticides listed under <b>Shuck Fall</b> .		
	Zolone helps control aphids but is only fair against plum curculio. Monitor 7 days after <b>Shuck Fall</b> insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.		
Brown rot	Use one of the fungicides listed under <b>Shuck Fall</b> .		

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Second Cover (12 days after First Cover)</b>			
Cherry fruit fly	• <sup>4</sup> Guthion 50 WP	2.75 kg	On early varieties, check interval from last spray to harvest date. Spray when early varieties are beginning to colour. Diazinon does not adequately control curculio. Zolone provides 12–14 days protection against cherry fruit fly while Diazinon provides 10 days. Make no more than 3 applications of Zolone Flo per season. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Plum curculio	• or <sup>4</sup> APM 50 W	2.75 kg	
	• or <sup>4</sup> Sniper 50 W	2.30 kg	
	• Diazinon 50 W	3.00 kg	
	• Zolone Flo	2.75 L	
Brown rot	• Rovral 50 WP	1.75 kg	Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in post-bloom sprays. Do not apply Rovral more than 2 times/season and never in consecutive sprays. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Captan 50 WP	7.50 kg	
	• or Captan 80 WP	4.50 kg	
	• or Maestro 75 DF	4.75 kg	
	• Sulphur 92 WP	19.50 kg	
	• <sup>5</sup> Topas 250 EC	500 mL	
<b>Third Cover</b>			
Cherry fruit fly	• Sevin XLR Plus	2.30 L	Sevin XLR Plus provides 5–7 days protection. Make no more than 3 applications of Zolone Flo per season. Check interval to harvest before spraying early maturing cherries.
	• Zolone Flo	2.75 L	
	• Diazinon 50 W	3.00 kg	
Brown rot	Add one of the fungicides listed under <b>Second Cover</b> .		
<b>Pre-Pick</b>			
Brown rot	• Rovral 50 WP	1.75 kg	Spray each variety just before picking. Do not apply Rovral more than 2 times per season and never in consecutive sprays. Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in post-bloom sprays.
	• Captan 50 WP	7.50 kg	
	• or Captan 80 WP	4.50 kg	
	• or Maestro 75 DF	4.75 kg	
	• Sulphur 92 WP	19.50 kg	
<b>Post Harvest on Fruit</b>			
Rhizopus rot (black whiskers)	• Botran 50 WP	875 g per 500 L water	Dip harvested cherries in suspension of Botran and keep the mixture well agitated during use. Read directions on label.
<b>Post Harvest</b>			
Leaf spot	• Equal 65 WP	2.25 kg	Only necessary where leaf spot is a problem, or where sweet cherries are beside sour cherries. Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in post-bloom sprays.
	• Captan 50 WP	7.50 kg	
	• or Captan 80 WP	4.50 kg	
	• or Maestro 75 DF	4.75 kg	
	• Ferbam 76 WDG	9.00 kg	
	• Benlate 50 WP	1.10 kg	
	plus Captan 50 WP	4.50 kg	

Visit the tree fruit page on the OMAFRA web site at  
[http://www.gov.on.ca/OMAFRA/english/crops/hort/tree\\_fruit.html](http://www.gov.on.ca/OMAFRA/english/crops/hort/tree_fruit.html)



# Peach & Nectarine Calendar

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide for Spraying Tree Fruits on page 12.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Dormant (In March or early April before buds swell)</b>			
Leaf-curl (Spring leaf-curl spray is not needed where a spray was applied last fall)	<ul style="list-style-type: none"> <li>Ferbam 76 WDG</li> <li><sup>4</sup>Bravo 500</li> </ul>	6.75kg 7.00 L	Delay may result in poor control of leaf curl. Do not apply Bravo 500 within 10 days of an oil application, as it will cause burning to flower and leaf tissue. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
San Jose scale	<ul style="list-style-type: none"> <li>Superior oil</li> </ul>	60 L	Apply oil routinely every third year. If scale is a serious or continuing problem, apply oil for at least 2 consecutive years. Oil may result in poor control of leaf curl. Ferbam should be added to water in a partially filled tank before oil is added. With agitator running, sift Ferbam slowly into water, or, preferably, slurry in with water in a pail and then add to tank. Add oil last, as remainder of water is being added. To keep mixture uniform, do not stop agitation until contents of tank are sprayed out. If oil is noticed floating on top of water, remix by turning a spray gun into tank. Injury may result to last few trees at the end of tank if emulsion breaks.
<b>Prebloom (Half-Inch Green to First Pink)</b>			
European red mite	<ul style="list-style-type: none"> <li>Superior oil</li> </ul>	60 L	Preferred time to use oil for red mite control if over-wintering populations are high. Red mite populations are more likely to be high when pyrethroid sprays were used the previous year for Oriental fruit moth and tarnished plant bug control.
<b>Pink through Bloom</b>			
Blossom blight stage of brown rot	<ul style="list-style-type: none"> <li>Nova 40 WP</li> <li><sup>4</sup>Bravo 500</li> <li>Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>Funginex 190 EC</li> <li>Rovral 50 WP</li> <li><sup>4</sup>Vangard 75 WG</li> <li><sup>5</sup>Topas 250 EC</li> <li>Sulphur 92 WP</li> </ul>	340 g 7.00 L 6.00 kg 3.75 kg 4.00 kg 2.50 L 1.50 kg 370 g 500 mL 20.25 kg	Spray when first blossoms are opening (late pink). Repeat every 4 to 5 days if weather is wet. To avoid resistance, alternate between fungicides and do not use Rovral, Funginex or Vangard more than 2 applications per season and never in consecutive sprays. For more information on resistance management of products such as Rovral or Vangard see <i>Brown Rot Control</i> on page 120. Use of sulphur may encourage mite buildup. Do not apply Bravo 500, Captan or Maestro within 10 days of an oil application, as it will cause burning to flower and leaf tissue. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
<b>Petal Fall and Shuck Spray</b>			
Mealy bug	<ul style="list-style-type: none"> <li><sup>6</sup>Parathion 15 W</li> </ul>	5.00 kg	Check for mealy bug when shucks start to split and if necessary apply spray at 50% shuck split and repeat in 10 to 12 days. Thorough coverage is essential to control mealy bug. <sup>6</sup> Minimum period for reentry is 7 days. See product label for specific reentry requirements and precautions.
Green peach aphid	<ul style="list-style-type: none"> <li><sup>3</sup>Pirimor 50 DF</li> </ul>	560 g	Restrict the application to no later than <b>Shuck Fall</b> . Observe the days to harvest interval. <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>First Generation Oriental Fruit Moth Spray—Shuck Split</b>			
Oriental fruit moth	• <sup>3</sup> Lorsban 50 W	3.40 kg	Widespread resistance has developed in most areas of Ontario to the organophosphate insecticides, Guthion/APM and parathion, and the carbamates such as Sevin. Resistance to pyrethroids is also developing at low levels.  The use of Lorsban for the control of generation #1 and pyrethroids for generations 2 to 4 provides an alternation of chemical families to avoid rapid selection of resistance to the pyrethroid insecticides. Do not use pyrethroids for first generation control of OFM.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>6</sup> Minimum period for reentry is 7 days. See product label for specific reentry requirements and precautions.
	• <sup>4</sup> Guthion 50 WP	2.00 kg	
	or <sup>4</sup> APM 50 W	2.00 kg	
	or <sup>4</sup> Sniper 50 W	2.30 kg	
	• Imidan 50 WP	3.75 kg	
	• <sup>6</sup> Parathion 15 W	5.00 kg	
Brown rot	• Rovral 50 WP	1.50 kg	Under rainy conditions, and high levels of blossom blight apply Rovral. Alternate between fungicides and do not use Rovral, or Vangard more than 2 applications per season and never in consecutive sprays. For more information on resistance management of products such as Rovral or Vangard see <i>Brown Rot Control</i> on page 120. Apply another fungicide in 7 days if wet weather persists.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Captan 50 WP	6.00 kg	
	or Captan 80 WP	3.75 kg	
	or Maestro 75 DF	4.00 kg	
	• Sulphur 92 WP	20.5 kg	
	• <sup>4</sup> Vangard 75 WG	740 g	
	• <sup>5</sup> Topas 250 EC	500 mL	
European red mite	If a dormant oil was not applied, use		Check leaves and apply early if 10–15 mites/leaf are present. Repeated use of Kelthane has led to red mite resistance.  Apollo kills mite eggs. Apply when leaf tissue is available, mites are mostly in the first summer generation egg stage, and before there are 3 active mites per leaf. Use sufficient water volumes to obtain good coverage, but not less than 475 L/ha. Apply up to 14 days after petal fall. Make no more than 1 application per season to prevent rapid development of mite resistance.
	• Apollo SC	300 mL	
	• Kelthane 50 W	3.25 kg	
Lesser peach tree borer Peach tree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4 EC or Endosulfan 400 EC • Sevin XLR Plus	1.50 kg/1000L 1.50 kg/1000L 1.75 L/1000L 1.75 L/1000L 2.30 L/1000L	In areas with high borer populations such as Essex and Kent counties, follow this spray regime. Make three applications beginning 5–10 days after the first oriental fruit moth spray, and continuing at three week intervals. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly. Check the days to harvest interval. Do not apply 2nd Thiodan spray to varieties in the Harrow Diamond and Garnet Beauty season. On these varieties use Sevin XLR Plus. Do not use third Thiodan spray on varieties in the Sunhaven, Redhaven, Veecling and Vivid season. On these varieties use Sevin XLR Plus.
<b>Special Sprays—Early Green Fruit Stage to Pit Hardening</b>			
Tarnished plant bug	• Cymbush 250 EC	280 mL	General timing is mid-June. Where plant bug pressure is high, sprays may have to be repeated in 5–7 days.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
	• <sup>3</sup> Matador 120 EC	104 mL	
	• Thiodan 50 WP	4.50 kg	
	or Endosulfan 50 W	4.50 kg	
	• <sup>4</sup> Guthion 50 WP	2.00 kg	
	or <sup>4</sup> APM 50 W	2.00 kg	
	or <sup>4</sup> Sniper 50 W	2.30 kg	

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Second Generation Oriental Fruit Moth Spray</b>			
Oriental fruit moth	<ul style="list-style-type: none"><li>• Cymbush 250 EC</li><li>• Decis 5 EC</li><li>• Pounce 384 EC</li><li>• <sup>3</sup>Matador 120 EC</li><li>• <sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li><li>• Imidan 50 WP</li><li>• <sup>6</sup>Parathion 15W</li></ul>	<ul style="list-style-type: none"><li>280 mL</li><li>200 mL</li><li>275 mL</li><li>104 mL</li><li>2.00 kg</li><li>2.00 kg</li><li>2.30 kg</li><li>3.75 kg</li><li>5.00 kg</li></ul>	<p>Spray all varieties. This generation may require two insecticide sprays applied about 14 days apart.</p> <p>Widespread resistance has developed in most areas of Ontario to the organophosphate insecticides, Guthion/APM and parathion, and the carbamates including Sevin. Resistance to pyrethroids is also developing at low levels. Where resistance is not a problem, Imidan or Guthion are recommended.</p> <p><sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.</p> <p><sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p> <p><sup>6</sup> Minimum period for reentry is 7 days. See product label for specific reentry requirements and precautions.</p>
Brown rot (early varieties only) Harrow Diamond through Sunhaven	<ul style="list-style-type: none"><li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li><li>• Rovral 50 WP</li><li>• Sulphur 92 WP</li><li>• <sup>4</sup>Vanguard 75 WG</li><li>• <sup>5</sup>Topas 250 EC</li></ul>	<ul style="list-style-type: none"><li>6.00 kg</li><li>3.75 kg</li><li>4.00 kg</li><li>1.50 kg</li><li>20.25 kg</li><li>740 g</li><li>500 mL</li></ul>	<p>Use of sulphur may induce mite problems.</p> <p>Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.</p> <p>For more information on resistance management of products such as Rovral or Vanguard see <i>Brown Rot Control</i> on page 120.</p> <p><sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p> <p><sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.</p>
<b>Special Sprays</b>			
European red mite Two spotted spider mite	<ul style="list-style-type: none"><li>• <sup>3</sup>Pyramite 75 WP</li><li>• Kelthane 50 W</li><li>• Carzol 92 SP</li></ul>	<ul style="list-style-type: none"><li>300 g</li><li>3.25 kg</li><li>1.10 kg</li></ul>	<p>This spray usually can be applied around the <b>Second Oriental Fruit Moth Spray</b> (early July). On cultivars Harbrite and later, examine for mites again 3 weeks before harvest. More than one mite per leaf (average) in mid-July can result in a mite infestation in Aug.</p> <p>Pyramite is the preferred material at this timing. Pyramite is most effective when applied to mite nymphs. A higher rate of 600 grams/ha may be necessary if outbreaks of two-spotted spider mites occur. Miticides are best used alone. Use a minimum water volume of 1000 L/ha for effective control. Pyramite has a 14 days to harvest interval. Make no more than 1 application per season.</p> <p>If 2 miticides are required during July and August on late maturing cultivars, be sure to alternate between materials. Observe days to harvest intervals.</p>
<b>Third Generation Oriental Fruit Moth Spray (Late Varieties)</b>			
Oriental fruit moth	<ul style="list-style-type: none"><li>• Cymbush 250 EC</li><li>• Decis 5 EC</li><li>• Pounce 384 EC</li><li>• Imidan 50 WP</li></ul>	<ul style="list-style-type: none"><li>280 mL</li><li>200 mL</li><li>275 mL</li><li>3.75 kg</li></ul>	Usually for all varieties from Harbrite–Vivid season and later (about Aug. 4).
Brown rot	<ul style="list-style-type: none"><li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li><li>• Rovral 50 WP</li><li>• Sulphur 92 WP</li><li>• <sup>4</sup>Vanguard 75 WG</li><li>• <sup>5</sup>Topas 250 EC</li></ul>	<ul style="list-style-type: none"><li>6.00 kg</li><li>3.75 kg</li><li>4.00 kg</li><li>1.50 kg</li><li>20.25 kg</li><li>740 g</li><li>500 mL</li></ul>	<p>To be included in all varieties.</p> <p>Use of sulphur may induce mite problems.</p> <p>Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.</p> <p>For more information on resistance management of products such as Rovral or Vanguard see <i>Brown Rot Control</i> on page 120.</p> <p><sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</p> <p><sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.</p>
<b>Prepick Spray</b>			
Oriental fruit moth	<ul style="list-style-type: none"><li>• Cymbush 250 EC</li><li>• Decis 5 EC</li><li>• Pounce 384 EC</li><li>• Imidan 50 WP</li></ul>	<ul style="list-style-type: none"><li>280 mL</li><li>200 mL</li><li>275 mL</li><li>3.75 kg</li></ul>	Spray each variety 7–10 days before first harvest when first colour shows. See comments on organophosphate resistance under <b>First Oriental Fruit Moth Spray</b> .

Diseases and Insects	Materials	Amount per Hectare	Comments
Brown rot	<ul style="list-style-type: none"> <li>• Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>• Rovral 50 WP</li> <li>• Sulphur 92 WP</li> <li>• <sup>4</sup>Vangard 75 WG</li> </ul>	6.00 kg 3.75 kg 4.00 kg 1.50 kg 20.25 kg 740 g	Apply with OFM sprays 7–10 days before harvest. Use Rovral if brown rot pressure is high (adjacent blocks with split pits) and weather is humid and/or wet.  Use of sulphur may induce mite problems.  For more information on resistance management of products such as Rovral or Vangard see <i>Brown Rot Control</i> on page 120  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Rhizopus rot	• Botran 75 WP	3.25 kg	
<b>Special Spray</b>			
Brown rot	<ul style="list-style-type: none"> <li>• Rovral 50 WP</li> <li>• Sulphur 92 WP</li> <li>• <sup>4</sup>Vangard 75 WG</li> </ul>	1.50 kg 20.25 kg 740 g	This spray is only necessary under rainy and humid conditions just prior to harvest (within 3 days of picking). This is the preferred time to use Rovral.  Use of sulphur may induce mite problems.  For more information on resistance management of products such as Rovral or Vangard see <i>Brown Rot Control</i> on page 120.  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>Post Harvest Treatment</b>			
Rhizopus rot (Black whiskers)	• Botran 75 WP	875 g/500 L	Dip harvested peaches in a suspension. Keep suspension agitated while dipping. Read the label. Apply 1 L wax on 3500 kg of fruit.
<b>Fall Spray (Preferred time to spray for leaf-curl)</b>			
Leaf-curl	<ul style="list-style-type: none"> <li>• Ferbam 76 WDG</li> <li>• <sup>4</sup>Bravo 500</li> </ul>	6.75 kg 7.00 L	Apply any time after leaves are off in fall or winter when temperature in shade is above freezing and conditions favour rapid drying  <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.

## Guidelines For Protecting Young Non-Bearing Peach Plantings

Diseases and Insects	Materials	Amount per Hectare	Comments
The following is designed to offer limited protection when needed for newly planted trees. It is not intended to be used for protection of bearing orchards. Rates are for dilute spraying.			
<b>Preplant</b>			
Nematodes	Peaches are very susceptible to nematodes, especially Siberian rootstock. See page 29 for nematode control.		
Lesser peach tree borer	• Thiodan 4 EC	1.25 L/100 L	If trees were not treated at the nursery, dip the roots and crown. Thiodan or Endosulfan wettable powder preparations must be stirred constantly to prevent settling out. The dip provides control for peach tree borer in the first year. Use rubber gloves to avoid exposing skin to insecticide. Dispose of excess material with extreme care. Thiodan and Endosulfan are extremely toxic to fish and wildlife.
Peach tree borer	• Thiodan 50 WP	1.25 kg/100L	
	or Endosulfan 50 W	1.25 kg/100L	
	• Endosulfan 400 EC	1.25 L/100L	
<b>First Oriental Fruit Moth and Borer Spray</b>			
Oriental fruit moth	• Cymbush 250 EC	93 mL	Widespread resistance has developed in Niagara to organophosphate insecticides, Guthion/APM and Parathion, and the carbamates including Sevin and Lannate. Monitoring of resistance in Niagara and other areas of the province continues. Where resistance is not a problem, Imidan or Guthion are recommended. <i><sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</i>
	• Decis 5 EC	67 mL	
	• Imidan 50 WP	1.25 kg	
	• <sup>4</sup> Guthion 50 WP	0.67 kg	
	or <sup>4</sup> APM 50 W	0.67 kg	
	or <sup>4</sup> Sniper 50 W	0.77 kg	
Lesser peach tree borer	• Thiodan 4 EC	1.75 L	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each <b>Oriental Fruit Moth Spray</b> in the second year. Borers invade trunks from the ground level up and may complicate canker infections. The problem appears to be more severe in Southwestern Ontario. Insecticides for OFM will help control borer if trunk coverage is thorough.
	• Thiodan 50 WP	1.50 kg	
	or Endosulfan 50 W	1.50 kg	
	• Endosulfan 400 EC	1.75 L	

## Guidelines For Protecting Young Non-Bearing Peach Plantings

Diseases and Insects	Materials	Amount per Hectare	Comments
Green peach aphid	• <sup>3</sup> Pirimor 50 DF	180 g	Green peach aphid may colonize and stunt new growth. Begin monitoring mid to late May for this pest. Apply controls when 30% of terminals are infested. <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
<b>Second Oriental Fruit Moth and Borer Spray</b>			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • <sup>4</sup> Guthion 50 WP or <sup>4</sup> APM 50 W • <sup>4</sup> Sniper 50 W	93 mL 67 mL 1.25 kg 0.67 kg 0.67 kg 0.77 kg	See comments on organophosphate resistance under <b>First Oriental Fruit Moth Spray</b> . <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Lesser peach tree borer	• Thiodan 4 EC • Thiodan 50 WP or Endosulfan 50 W • Endosulfan 400 EC	1.75 L 1.50 kg 1.50 kg 1.75 L	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each <b>Oriental Fruit Moth Spray</b> in the second year.
Green peach aphid	• <sup>3</sup> Pirimor 50 DF	180 g	<sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions.
<b>Third Oriental Fruit Moth and Borer Spray</b>			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • <sup>4</sup> Guthion 50 WP or <sup>4</sup> APM 50 W • <sup>4</sup> Sniper 50 W	93 mL 67 mL 1.25 kg 0.67 kg 0.67 kg 0.77 kg	See comments on organophosphate resistance under <b>First Oriental Fruit Moth Spray</b> . <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Lesser peach tree borer	• Thiodan 50 WP or Endosulfan 50 W • Endosulfan 400 EC or Thiodan 4 EC	1.50 kg 1.50 kg 1.75 L 1.75 L	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each <b>Oriental Fruit Moth Spray</b> in the second year.

Visit the tree fruit page on the OMAFRA web site at  
[http://www.gov.on.ca/OMAFRA/english/crops/hort/tree\\_fruit.html](http://www.gov.on.ca/OMAFRA/english/crops/hort/tree_fruit.html)



# Non-Bearing Plantings

## Mites:

Mites are usually not a problem on non-bearing trees. Trees can tolerate about 30 mites per leaf.

## Cankers:

Perform canker surgery and dead wood removal in June or July when rapid growth and the healing of the tree can take place. Conduct surgery when there is a forecasted period of dry weather following.

During surgery remove all diseased bark around the canker and about 3–5 cm of healthy tissue from around the sides

and ends, respectively. The resulting wound, when finished, should have a smooth margin and be slightly rounded above and below to favour rapid wound closure. Surgery sites in June and July are thought to heal best if left uncovered without wound dressing. Some pruning paints actually seal in moisture, providing an ideal environment for fungal infection.

## Southwest Injury and Rodent Control

The use of latex paint plus Thiram is strongly recommended. The whole trunk, plus the base of major scaffolds should be painted. See page 33 for details.

## Insect Control

### Plant Bugs

There are 2 sources of plant bug:

- residents that overwinter within the orchard and
- migrants that overwinter on hosts outside the orchard and disperse into the orchard during the growing season.

In addition to the insecticide sprays listed in the calendar, try using the following cultural methods to minimize the size of the resident populations and to provide an alternate food source for the summer generations of migrant plant bugs.

- Remove any large oak trees adjacent to peach blocks to avoid oak bug injury. White and red oaks are more important than the Burr type.
- Apply a contact herbicide in the herbicide strip areas e.g., paraquat, to early season hosts of plant bug which are mainly mint, creeping charlie and annual and perennial chickweed. In most years, apply herbicide by about April 20th in Southwestern Ontario and May 1st in the Niagara Peninsula.

- Apply a second herbicide such as a contact plus residual to the herbicide strip area in the latter part of May in order to provide season long control of weeds in your orchard.
- Where clean cultivation is practiced, begin as early as possible and continue up to about May 15th in Southwestern Ontario and June 1st in the Niagara Peninsula. Early cultivation will reduce the number of resident plant bugs. Stop cultivation during June to encourage the establishment of weeds such as pigweed and lamb's-quarters. These provide an alternate food source for first generation plant bugs and thus discourage feeding on peach fruit.
- Where sod culture is adopted, mow frequently, for example every 2 weeks. Use fertilizer and herbicides as needed to encourage weed-free sod. Creeping red fescue or other grasses are the preferred species for sod. Avoid clover.
- Where the use of cover crops in cultivated peach orchards is practiced to lower nitrogen levels and check tree growth, delay preparing and sowing of the cover crop until July 10th when the major danger of extensive plant bug injury is over.

## Peach Canker

The following practices aid greatly in the prevention of peach canker. When pruning, avoid cutting into the collar area of the branch or limb where it meets scaffolding or the trunk of the tree. Evidence from the United States and Ontario suggests that when the collar area is injured or cut in any way, the healing process is delayed or impaired, since wounded periderm tissues are located primarily in the collar region.

### At Planting Time and First Year

- Plant good nursery stock. Use Thiodan dip for borer control. See *Guidelines for Protecting Young Non-Bearing Peach Plantings, Preplant*, page 133.
- When pruning at planting time, remove all poor angles and weak side branches.
- Go over trees in mid-June and remove all dead wood and obviously poorly angled live branches.

## Disease Control

- Apply sprays for fruit moth, peach tree and lesser borer.
- Sow a cover crop (early July).
- Protect trees from rabbits and mice.

### Second Year and Following Years

- Apply nitrogen fertilizers early (March, April) to bearing trees. Avoid late applications of manure.
- Prune as late in the spring as possible. Prune 2 and 3-year-old trees after bloom.
- Do not prune immediately preceding rains.
- Remove all dead wood and poorly angled branches.
- Go over scaffolds in June and remove dead wood and poorly placed new growth.
- Apply sprays for fruit moth, peach tree borers, plant bugs and brown rot.
- Sow a cover crop (early June).
- Protect trees from rabbits and mice.

Peach thinning is essential for good orchard management and is necessary to obtain fruit of good size and quality.

Most peach cultivars have the potential for over-cropping which results in limb breakage, reduced fruit size and quality, loss of tree vigour, shortened orchard life, and increased pest management problems. Optimum fruit load depends on cultivar, tree vigour, orchard management activities (tree spacing, irrigation, pruning,), tree age, and tree health (winter injury, canker).

Often fruit spacing receives more attention than fruit load. Orchardists tend to think of spacing the fruit 15–20 cm apart. Distance between fruit is not too critical as long as clusters are broken up and fruits are separated. Tree crop load (kg/tree or number of fruits/tree) is a more important consideration. As an example, a yield of 18–27 tonnes/ha (8–12 t/acre) in an orchard with a tree density of 490 trees/ha (200 trees/acre) requires about 200–300 fruits per tree assuming an average fruit size of 4–7 fruits/kg

## Thinning Peaches

(2–3 fruits/lb). With current emphasis on increased fruit size for better marketability and trends towards higher tree densities, fruit loads of 175–200 fruits per tree may be more ideal, at least for larger-fruited cultivars.

Some factors that must be taken into consideration are:

**Pruning** — is an essential part of the fruit thinning procedure. A considerable amount of the fruit-bearing surface is selectively removed therefore also removing some of the excess crop. Normal fruit thinning must follow to avoid over-cropping.

**Timing** — Start thinning near the end of June drop (about mid June) when you can determine which fruits will abort and fall on their own. Thinning at early fruit development or even blossom time has more benefits than late thinning. However, it is difficult to get a true assessment of crop load before June drop has occurred.

**Cultivars** — Early ripening cultivars, such as Candor, frequently bear a fairly high percentage of fruit having split pits. Growers often lightly thin once early to remove some crop load, then a second time to selectively remove split-pit fruits. Harrow Diamond ripens with Candor but has few split-pit fruits. This cultivar must be well thinned to obtain suitable size. There is little likelihood of over-thinning early cultivars when the set is heavy. Heavy-setting, hard-to-size cultivars such as Redhaven require heavier thinning than easier to size types like Vivid and Loring. As a rule of thumb, however, late maturing cultivars with a good, uniform set are usually thinned 10–13 cm apart. Cultivars are different and are thinned according to their individual requirements.

**Irrigation** — In many commercial farms, irrigation is a beneficial management tool to enhance fruit size especially during drought conditions. Irrigation should start early in the season and continue on a regular schedule depending upon the amount of natural rainfall. Growers without irrigation in some years may need to consider a second thinning during July to attain marketable fruit size.

Thinning is most commonly accomplished by hand with manual labour. Physical aids such as a child's plastic bat, a rubber hose mounted on a bamboo pole or broom handle, or a plastic rake manufactured for this purpose are useful to remove large quantities of fruit in a hurry. Initial thinning often is followed up by a "touch-up" thinning to assure that fruit numbers per tree conform to conditions and standards set for the cultivar and the orchard. It is important to ensure that clusters are broken up and fruits separated. If the set is spotty on the tree, more fruits may be left on the heavy-set branches.

Other methods that have been investigated are:

**Mechanical trunk shaker:** This method is erratic and can result in over-thinning. The long term effect on the root system has yet to be determined.

**Rope thinning of blossoms:** This method needs further investigation. Timing is a problem because this conflicts with pruning.

**Chemical thinning:** There are presently no chemicals registered for fruit thinning in Ontario.

Any of the above methods must be supplemented by touch-up hand thinning.

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide for Spraying Tree Fruits on page 12.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Dormant</b>			
Scale insects Pear psylla	• Superior oil (60–70 vis.)	60 L	Apply full rate of oil in 2000–3000 L of water per hectare. 3000 L will give best results. Good coverage is essential. Do not apply full rate of oil more than once per season.
<b>Green Tip</b>			
Scab	• Equal 65 WP • Captan 50 WP or Captan 80 WP or Maestro 75 DF • Dikar WP • Benlate 50 WP plus Manzate 200 80 WP	3.25 kg 6.00 kg 3.75 kg 4.00 kg 6.75 kg 550 g 3.25 kg	It is important to start scab control early and repeat the spray if weather remains wet. Do not use Maestro on d'Anjou pears. When Dikar is used in a full season program at 10 day intervals, it will control pear scab and nymphal stages of pear psylla. It will also suppress European red mite and rust mite populations. It must not be used within 45 days of harvest. Higher water volumes aid in mite suppression. Alternate Benlate–Manzate with full rates of Captan, Dikar, or Equal to avoid Benlate resistance.
European red mite Pear psylla	• Superior oil	60 L	Best applied at or near <b>Green Tip</b> for mites. Good coverage is necessary. Oil is not effective for rust mite control. Do not apply full rate of oil more than once per season.
<b>Prebloom (As blossoms show white at tips)</b>			
Scab	Use one of the materials listed for scab control under <b>Green Tip</b> .		Repeat spray if weather remains wet.
Rust mite European red mite	• Carzol 92 SP • Kelthane 50 W	1.10 kg 3.25 kg	Carzol is harsh on beneficial mites and honey bees. Some resistant mites may be present when Kelthane has been used for four or more years and an alternative miticide is advisable.
Pear psylla	• <sup>4</sup> Guthion 50 WP or <sup>4</sup> APM 50 W or <sup>4</sup> Sniper 50 W • Thiodan 50 WP or Endosulfan 50 W	2.10 kg 2.10 kg 2.30 kg 6.75 kg 6.75 kg	To avoid resistance problems, synthetic pyrethroids are not recommended at this time. Refer to comments at <b>First Cover</b> . Guthion and APM will also control green fruitworm. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Green fruitworm Obliquebanded leafroller	• Dipel WP or Foray 48 BA • Imidan 50 WP • <sup>4</sup> Guthion 50 WP or <sup>4</sup> APM 50 W or <sup>4</sup> Sniper 50 W	2.25 kg 2.80 L 3.75 kg 2.10 kg 2.10 kg 2.30 kg	These products will only suppress obliquebanded leafroller. B.t. formulations such as Dipel and Foray are most effective when larvae are actively feeding and weather is warm and dry for three days after application. Two to 3 applications of B.t. may be required to cover the extended emergence of overwintering larvae. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Plant bugs	• Thiodan 50 WP or Endosulfan 50 W	4.50 kg 4.50 kg	Thiodan helps to control psylla.

All pear varieties in Ontario are commercially self-unfruitful, and mixed plantings are necessary. Insects are required for cross-pollination. Honey bees do not find pear blossoms as attractive as most other fruit. Careful timing of the introduction of honey bees to orchards is necessary. Up to 8 hives per hectare are recommended to be placed when the orchard is about 25% in bloom. The use of pollen inserts will help to overcome this problem.

#### Bloom

Do not apply insecticides while pears are in bloom.

See Bee Poisoning page 41

Fire blight	• Streptomycin 17	600 g/1000 L	Sprays are most effective when applied dilute (high volumes of water prior to a wetting period). Use alone for best results. Because Streptomycin 17 is UV light sensitive it is only effective for 2–3 days if warm wet conditions (above 20°C) prevail. Two to 4 sprays during the bloom may be required for fire blight control. To avoid resistance use a maximum of 4 sprays per season. (See <i>Fire Blight of Pear</i> , page 142).
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Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Petal Fall</b>			
Pear psylla Plum curculio	<ul style="list-style-type: none"><li>• <sup>3</sup>Agri-Mek 1.9 EC</li><li>• <sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50% W or <sup>4</sup>Sniper 50 W</li><li>• Thiodan 50 WP or Endosulfan 50 W</li></ul>	<ul style="list-style-type: none"><li>1.00 L</li><li>2.10 kg</li><li>2.10 kg</li><li>2.30 kg</li><li>6.75 kg</li><li>6.75 kg</li></ul>	Thiodan and Endosulfan are not registered for plum curculio control. Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L superior oil and a minimum of 1000 L of water per hectare. Apply when majority of population is in the nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. Do not use within 14 days of a Captan application. Do not apply more than once per season. Ideally, alternate yearly with other insecticides (e.g. Mitac). Agri-Mek will not control plum curculio. <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Rust mite European red mite	Add one of miticides listed in <b>Prebloom</b> .		A single miticide applied at prebloom or at petal fall is necessary for good mite control. Rust mite must be controlled no later than petal fall to avoid russeted fruit at harvest. Alternate miticides.
Leaf spots Scab	Add one of the fungicides listed for scab at <b>Green Tip</b> .		If wet weather persists, additional sprays will be needed for scab control before <b>First Cover</b> .
<b>Special Spray</b>			
Mealy bug	<ul style="list-style-type: none"><li>• <sup>6</sup>Parathion 15 WP</li></ul>	2 kg/1000 L	Where there is a problem spray at <b>Petal Fall</b> and <b>First Cover</b> , a dilute spray is necessary for good control. <sup>6</sup> Minimum period for reentry is 7 days. See product label for specific reentry requirements and precautions.
Codling moth	<ul style="list-style-type: none"><li>• Imidan 50 WP</li><li>• <sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li></ul>	<ul style="list-style-type: none"><li>3.75 kg</li><li>2.10 kg</li><li>2.10 kg</li><li>2.30 kg</li></ul>	Codling moth may cause economic fruit losses if pear plantings are located near wild apple and pear hosts infested with codling moth. The use of Mitac and Agrimek in pear psylla programs provides no protection of fruit against codling moth. For sites with a history of codling moth damage, growers should apply 1 of these insecticides. Use codling moth timing as recommended for apple. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>First Cover (about June 25)</b>			
Pear psylla	<ul style="list-style-type: none"><li>• <sup>7</sup>Mitac WP</li><li>• Thiodan 50 WP or Endosulfan 50 W</li><li>• <sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li><li>• Decis 5 EC</li><li>• Ripcord 400 EC or Cymbush 250 EC</li><li>• Pounce 384 EC</li><li>• <sup>3</sup>Matador 120 EC</li><li>• <sup>3</sup>Agri-Mek 1.9 EC</li></ul>	<ul style="list-style-type: none"><li>2.50 kg</li><li>6.75 kg</li><li>6.75 kg</li><li>2.10 kg</li><li>2.10 kg</li><li>2.30 kg</li><li>350 mL</li><li>250 mL</li><li>280 mL</li><li>520 mL</li><li>83 mL</li><li>1.00 L</li></ul>	Mitac, like other products should be applied when the majority of the population is in the early instar stages. Mitac should be used only once per season and when populations of psylla are high, e.g., greater than 25 active per sucker. Where plum curculio is a later season problem, use one of the materials recommended at <b>Petal Fall</b> .  Mitac will also control European red mite.  Resistance to pyrethroid insecticides (Decis, Ripcord, Cymbush, Pounce, Matador) is widespread.  Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L superior oil and a minimum of 1000 L of water per hectare. Apply when majority of population is in the nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. Do not use within 14 days of a Captan application. Do not apply more than once per season. Ideally, alternate yearly with other insecticides (e.g. Mitac). Agri-Mek will not control plum curculio.  <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>7</sup> See product label for specific reentry requirements and precautions.
Scab	Add one of the fungicides listed under <b>Green Tip</b> . Reduce rate of Equal to 2.25 kg/ha in cover sprays.		



Diseases and Insects	Materials	Amount per Hectare	Comments
Obliquebanded leafroller	<ul style="list-style-type: none"> <li>Dipel WP or Foray 48 BA</li> <li><sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li> <li>Imidan 50 WP</li> </ul>	2.25 kg 2.80 L 2.10 kg 2.10 kg 2.30 kg 3.75 kg	Resistance to the organophosphates such as Imidan and Guthion/APM is becoming more widespread. All of these products will only suppress leafroller populations. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>Special Spray</b>			
Blister mite	<ul style="list-style-type: none"> <li>Sevin XLR Plus</li> <li>Thiodan 50 WP or Endosulfan 50 W</li> </ul>	2.30 L 4.50 kg 4.50 kg	
<b>Summer Sprays</b>			
Pear psylla	<ul style="list-style-type: none"> <li><sup>7</sup>Mitac WP</li> <li><sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li> <li>Thiodan 50 WP or Endosulfan 50 W</li> <li>Decis 5 EC</li> <li>Ripcord 400 EC or Cymbush 250 EC</li> <li>Pounce 384 EC</li> <li><sup>3</sup>Matador 120 EC</li> </ul>	2.50 kg 2.10 kg 2.10 kg 2.30 kg 6.75 kg 6.75 kg 350 mL 250 mL 280 mL 520 mL 83 mL	Mitac, like other products for psylla control, should be applied when the majority of the population are in the early instar stages. Mitac should be used only once per season and when population of psylla are high, e.g., greater than 25 active per sucker. Mitac will also control European red mite. Guthion or APM are the most effective summer insecticides to control codling moth, if it should become a problem. <sup>3</sup> Minimum period for reentry is 24 hrs. See product label for specific reentry requirements and precautions. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>7</sup> See product label for specific reentry requirements and precautions.
Codling moth	<ul style="list-style-type: none"> <li>Imidan 50 WP</li> <li><sup>4</sup>Guthion 50 WP</li> <li><sup>4</sup>APM 50 W</li> <li><sup>4</sup>Sniper 50 W</li> </ul>	3.75 kg 2.10 kg 2.10 kg 2.30 kg	Codling moth may cause economic fruit losses if pear plantings are located near wild apple and pear hosts infested with codling moth. The use of Mitac and Agrimek in pear psylla programs provides no protection of fruit against codling moth. For sites with a history of codling moth damage, growers should apply one of these insecticides. Use codling moth timing as recommended for apple. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Mites	<ul style="list-style-type: none"> <li>Kelthane 50 W</li> <li>Carzol 92 SP</li> </ul>	3.25 kg 1.10 kg	Examine orchards for red mite and rust mite injury about July 15–20 or 10–15 days after using a synthetic pyrethroid. Do not apply closer to harvest than the number of days given in Table 13-3, page 214. Alternate miticides. Carzol is harsh on beneficial mites.
<b>Second Cover</b>			
Scab	Add one of the fungicides listed under <b>Green Tip</b> . Reduce rate of Equal to 2.25 kg/ha in cover sprays. Dikar and Manzate have a 45 days to harvest interval.		
Sooty blotch	<ul style="list-style-type: none"> <li>Captan 50 WP or Captan 80 WP or Maestro 75 DF</li> <li>Zineb 80 W</li> </ul>	6.00 kg 3.75 kg 4.00 kg 6.00 kg	Repeat spray for sooty blotch 2 weeks later. Do not use Maestro on d'Anjou pears.
<b>Special Sprays (about mid-August and early-September)</b>			
Obliquebanded leafroller Codling moth	<ul style="list-style-type: none"> <li>Dipel WP or Foray 48 BA</li> <li><sup>4</sup>Guthion 50 WP or <sup>4</sup>APM 50 W or <sup>4</sup>Sniper 50 W</li> <li>Imidan 50 WP</li> </ul>	2.25 kg 2.80 L 2.10 kg 2.10 kg 2.30 kg 3.75 kg	Codling moth, as well as Oriental fruit moth, can infest pear as maturation and ripening begins. Bosc pears can be heavily infested and may require two preharvest sprays about 2 weeks apart. For Bosc, Anjou and Bartlett a spray 7–10 days prior to harvest is recommended in orchards adjacent or nearby peaches. Most Oriental fruit moth populations are resistant to the organophosphates, Imidan and Guthion. In years and sites with high Oriental fruit moth populations, intervals between preharvest sprays should be shortened to 7 days from 14 days. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
<b>Postharvest Treatment</b>			
Blue mould Gray mould	<ul style="list-style-type: none"> <li>Mertect 45 F</li> </ul>	500 mL/ 500 L water	For use in dip tank or drencher. Continuous agitation required. Follow label instructions. Does not control any blue mould ( <i>Penicillium</i> ) or gray mould ( <i>Botrytis</i> ) which is resistant to benzimidazole fungicides (e.g., Benlate).

## Guidelines for Protecting Young Non-Bearing Pear Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended to be used for protection of bearing orchards. Other protective measures include the removal of neglected fruit trees in the area, careful selection of intercrops (where used) and a clean, weed-free environment. Rates are for dilute spraying. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Materials	Amount per 1000 L	Comments
Fire blight	• Streptomycin 17	600 g	Avoid excess nitrogen applications. Conduct regular leaf analysis. See <i>Fire blight of Pear</i> , page 142.
Pear psylla	• Thiodan 50 WP or Endosulfan 50 W	1.50 kg 1.50 kg	If nymphs are observed, spray when 75% of the petals have fallen in nearby bearing orchards.
Leaf-feeding insects	• Imidan 50 WP	1.25 kg	Apply at any time when small caterpillars are feeding.
Pear psylla (summer broods)	• Thiodan 50 WP or Endosulfan 50 W	1.50 kg 1.50 kg	Target early nymphal stages.
European red mite	• Carzol 92 SP	0.37 kg	Check foliage frequently and spray if 7–10 mites/leaf are observed or at first sign of leaf bronzing.

Visit the tree fruit page on the OMAFRA web site at  
[http://www.gov.on.ca/OMAFRA/english/crops/hort/tree\\_fruit.html](http://www.gov.on.ca/OMAFRA/english/crops/hort/tree_fruit.html)

## Fire Blight of Pear

Fire blight can be a major disease problem for Ontario pear growers. The following practices can help reduce blossom and shoot blight infection.

### Cultural Practices

Make use of tissue and soil analysis to avoid applying excessive amounts of nitrogen fertilizer in the spring. Succulent, rapidly growing shoots and suckers are more susceptible to fire blight infection.

Remove all diseased wood in the dormant season (in January or February) when temperatures are below freezing. Patrol orchards at least twice per week when blossom and shoot blight symptoms are predicted to occur. When the number of strikes is low, remove these new infections from the orchard to avoid further spread of the disease. New infections must be pruned out at least 30–45 cm below discoloured wood using pruning tools.

Pruning tools can be disinfected by mixing one part household bleach in four parts water. Store bleach solution in well-labeled closed plastic or glass container. After use, wash and oil tools to prevent rust. Denatured alcohol (ethanol) is a better disinfectant than the bleach solution and will not rust tools.

Removal of secondary blossoms before they become infected will reduce the potential for fire blight. Secondary blossoms on Bartlett pear probably pose the greatest risk for fire blight infections, but are often too numerous to remove.

### Chemical Control

In spring, warm temperatures (18°C or greater) and moisture (rain or heavy dew) favour infection of blossoms. When these conditions are predicted, and they persist through the blossom period, protect the blossoms with Streptomycin 17 at 100 ppm (100 ppm = 600g product/1000 L water). Spray during slow drying conditions. Spray is most effective when applied dilute (high volumes of water) prior to a wetting period. For best results use Streptomycin 17 alone in the tank. Because it is sensitive to ultraviolet light, Streptomycin 17 is effective for only 2–3 days. Re-application is also needed to protect newly opened blossoms, after 2–3 days, if warm, wet conditions (above 18°C) prevail. Two to 4 sprays during the bloom

period may be necessary to protect blossoms against fire blight infection.

In non-bearing orchards, copper sprays may be substituted for Streptomycin 17. However, copper sprays are less effective than Streptomycin 17 for controlling fire blight. The copper sprays should be mixed with lime according to label directions. For more information on registered formulations, rates and mixing instructions see *Use of Copper Products on Fruit Crops* on page 34.

**Excessive use of Streptomycin 17 may lead to the development of fire blight resistance.**

If hail or damaging winds occur during the growing season, apply Streptomycin 17 within 12 hours to prevent serious damage to the fruit and trees. Beyond 24 hours, streptomycin is not effective. Ensure a 30-day to harvest interval on pears.

**For best results, combine all cultural and chemical control methods to keep fire blight at a manageable level in the orchard.**

### Predicting Fire Blight Infections

Maryblyt is a computer modeling program. It is designed to predict fire blight infection by using daily minimum and maximum temperatures, rainfall amounts and wetness resulting from heavy dew and by inputting forecasted weather. Advanced warning (1–4 days) of fire blight infection is provided during the critical susceptible growth stages. The most precise prediction for your farm is obtained when you collect and input your own data using Maryblyt. Copies are available from Gempler's Pest Management Supply, P. O. Box 270, Mt. Horeb, WI., 53572 USA. Telephone: 1-800-272-7672 or 1-608-437-4883; or FAX 1-800-551-1128

## Blue Mould and Gray Mould in Stored Pears

Under certain conditions rot can develop on pears during storage. Disease organisms are common in and around grading lines, work areas and storages. Fungi causing blue mould (*Penicillium*) and gray mould (*Botrytis*) are spread in air currents and by water.

Infection of pears most commonly occurs after harvest through stem punctures, wounds, skinbreaks and heavy bruises. These fungi can be transferred from contaminated bins, water used for dipping or drenching, and grading equipment.

Rot will develop faster if the infected pears are delayed going into storage, are cooled slowly in storage, are stored for a longer period, or are held at warm temperatures after removal from storage.

### Reducing Disease Development

Careful handling during and after harvest to minimize stem punctures, skin breaks and bruising can greatly reduce the number of infection sites on the fruit.

At the storage, lift truck operators must also move the bins with a minimum of jolting and dropping. Refrigerate the fruit as quickly as possible. Adequate refrigeration capacity for each storage room is required. Modern refrigeration facilities and the use of CA atmospheres also reduce the development of fruit rot.

Sanitation in the handling/grading area is very important. Careful and frequent removal and disposal of rotted fruit from the premises will greatly reduce the dispersal and spread of disease organisms within the building.

Frequent changing of the water used for dipping or drenching will reduce the accumulation of fungal spores in the water and thus greatly reduce the risk of fruit infection.

### Postharvest Treatment

Thiabendazole (TBZ) can reduce disease incidence. A formulation called Mertect 45% F is registered in Ontario to control the development of *Penicillium spp* (e.g. blue mould) and *Botrytis cinerea* (e.g. gray mould) on stored apples and pears. Mertect 45% F can be used as a post harvest dip or drench. The rate is 0.5 L of product in 500 L of water. Certain precautions must be followed.

- Constant agitation is required to maintain a suspension during treatment.
- Mertect must be in direct contact with the skin of the fruit. Do not apply wax prior to Mertect treatment.
- Consult the label for additional instructions.

Research and field experience indicates that resistant strains of these diseases are common. Resistant strains are not controlled by treatment with thiabendazole.

The addition of diphenylamine (DPA) in the post harvest treatment (to reduce storage scald) is reported to control some resistant strains of blue mould (*Penicillium*) and gray mould (*Botrytis*).

## Thinning Pears

The major pear cultivars grown in Ontario benefit from fruit thinning. The thinning of fruit will be particularly beneficial during seasons of heavy fruit set or inadequate moisture. Bartlett and Bosc can set fruit in clusters of 3–5 fruits per spur. If fruit set is excessive, reduce the number of fruit per cluster to 1 or 2. If the set on the tree is not excessive, multiple fruits per cluster will reach a satisfactory size without implementation of fruit thinning.

Start thinning near the end of June drop (mid-June) when it can be determined which fruits will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Pears on dwarfing rootstock must be thinned in order to obtain a high percentage of marketable fruit and prevent limb breakage. De-fruit trees during the first 4 years of

establishment. Reduce the crop to 1 fruit per spur and spaced 12–15 cm apart during normal years. Pear fruit size on dwarfing rootstock will not only benefit from proper thinning but irrigation as well.

Response of pears to chemical agents, under Ontario conditions, is inconsistent from year to year. Try chemical thinning on a small scale until you have evaluated response in relation to tree vigour, cultivar, and fruit size.

Growers wishing to try chemical thinning of pears will obtain the best results using either NAA (*naphthaleneacetic acid*) or NAD (*naphthaleneacetamide*). The suggested rates are: NAA at a concentration of 15–20 ppm approximately 3–6 days after petal fall, or NAD at 10 ppm 6–9 days after petal fall, depending on tree vigour and amount of thinning desired.

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide for Spraying Tree Fruits, page 12.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Green Tip (Just as buds are bursting)</b>			
European red mite Scale insects	• Superior Oil	60 L	Spray on a calm day to improve coverage.
<b>Prebloom (When blossoms show white)</b>			
Brown rot	• Rovral 50 WP	1.50 kg	To help control brown rot, knock off mummied fruit when pruning. Cultivate entire orchard before bloom. To avoid resistance, alternate between fungicides and do not use more than 2 applications of Rovral or Vanguard per season. See note on brown rot control, <i>Brown Rot Control</i> on page 120. Sulphur helps control rust mites on European plums and prunes. Captan or Maestro may cause injury under some circumstances. Injury has occurred on Grand Prize, Early Golden, Shiro, Burbank and Ozark Premier. Make 2-3 applications from early to full bloom. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Captan 50 WP	6.00 kg	
	or Captan 80 WP	3.75 kg	
	or Maestro 75 DF	4.00 kg	
	• Sulphur 92 WP	19.50 kg	
	• Funginex 190 EC	2.50 L	
• <sup>4</sup> Vangard 75 WG	370 g		
• <sup>5</sup> Topas 250 EC	500 mL		
Black knot	• Captan 50 WP	6.00 kg	Destroy affected wild and neglected plums near orchard. Cut out and burn all black knots before March. Make the cut 15 cm below the swelling. Collect and burn all prunings with knots. Knots left lying on the ground are a source of spores that start new infections. Inspect all plums in early summer for new knots and those that were missed. Cut these out and burn them. European plums, prunes and damsons are most susceptible. Fungicide sprays should be applied to protect the developing shoots between the popcorn stage (prebloom) and first cover every 3-5 days in wet weather. Spore release may be delayed in dry springs when rains are delayed until after bloom. Under these conditions extend fungicide coverage to first cover.
	or Captan 80 WP	3.75 kg	
	or Maestro 75 DF	4.00 kg	
Both European and Japanese plums should be considered as self-unfruitful. Mixed plantings and insect pollinators are essential. Honey bees readily work plum blossoms.			
<b>Bloom</b>			
Do not apply insecticides while plum trees are in bloom.			
See Bee Poisoning, page 41			
Brown rot (Blossom blight)	Use one of the fungicides listed under <b>Prebloom</b> .		
<b>Shuck (When most of the shucks are off)</b>			
Brown rot	• Rovral 50 WP	1.50 kg	Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances. To avoid resistance, alternate between fungicides and do not use more than 2 applications of Vanguard or Rovral per season. See <i>Brown Rot Control</i> on page 120. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
	• Sulphur 92 WP	19.50 kg	
	• Captan 50 WP	6.00 kg	
	or Captan 80 WP	3.75 kg	
	or Maestro 75 DF	4.00 kg	
	• <sup>4</sup> Vangard 75 WG	740 g	
• <sup>5</sup> Topas 250 EC	500 mL		
Black knot	• Captan 50 WP	6.00 kg	Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances.
	or Captan 80 WP	3.75 kg	
	or Maestro 75 DF	4.00 kg	
Plum curculio	• <sup>4</sup> Guthion 50 WP	2.00 kg	If temperatures are high, spray when the shucks split. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>6</sup> Minimum period for reentry is 7 days. See product label for specific reentry requirements and precautions.
	or <sup>4</sup> APM 50 W	2.00 kg	
	• <sup>4</sup> Sniper 50 W	2.30 kg	
	• Imidan 50 WP	3.75 kg	
	• <sup>6</sup> Parathion 15 WP	3.25 kg	



Diseases and Insects	Materials	Amount per Hectare	Comments
European red mite	• Kelthane 50 W	3.25 kg	If oil was not used at <b>Green Tip</b> a spray for mites is due at this time.
<b>First Cover (12 days after Shuck)</b>			
Brown rot Leaf spot Black knot	Use one of the fungicides listed under <b>Shuck</b> .		Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances.
Plum curculio	Use one of the insecticides listed under <b>Shuck</b> .		
<b>Summer Spray</b>			
European red mite	• Kelthane 50 W	3.25 kg	
<b>Second Cover</b>			
Brown rot	• Rovral 50 WP • Sulphur 92 WP • Captan 50 WP or Captan 80 WP or Maestro 75 DF • <sup>4</sup> Vanguard 75 WG • <sup>5</sup> Topas 250 EC	1.50 kg 19.50 kg 6.00 kg 3.75 kg 4.00 kg 740 g 500 mL	During wet weather repeat applications between pickings. Check interval to harvest for materials. See Table 13-3 on page 214. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions. <sup>5</sup> Minimum period for reentry is 72 hrs. See product label for specific reentry requirements and precautions.
<b>Prepick</b>			
Brown rot	Use one of the fungicides listed under <b>Second Cover</b> .		
<b>Special Sprays</b>			
Aphids	• Thiodan 50 WP or Endosulfan 50 W • Diazinon 50 W	3.25 kg 3.25 kg 3.00 kg	Apply only if aphids are a problem. Very thorough coverage and calm warm conditions are needed for good control.
Apple maggot	• Diazinon 50 W • <sup>4</sup> Guthion 50 WP or <sup>4</sup> APM 50 W or <sup>4</sup> Sniper 50 W • Imidan 50 WP	3.00 kg 2.00 kg 2.00 kg 2.30 kg 3.75 kg	If apple maggot has been a problem on blue plums and prunes, apply 2 or 3 sprays during July and Aug. <sup>4</sup> Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.
Peach tree borer Lesser peach tree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4EC or Endosulfan 400EC • Sevin XLR Plus	1.5 kg/1000L 1.5 kg/1000L 1.75L/1000L 1.75L/1000L 765mL/1000L	Apply three sprays, 3 weeks apart. Apply first spray 10 days after first adult catch in pheromone traps. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals and do not spray if fruit is to be harvested during this period.

Visit the tree fruit page on the OMAFRA web site at  
[http://www.gov.on.ca/OMAFRA/english/crops/hort/tree\\_fruit.html](http://www.gov.on.ca/OMAFRA/english/crops/hort/tree_fruit.html)

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## Disease Control

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### Heat Spot

High temperatures may cause purplish spots on plum and prune fruits that exude clear gum. These spots develop about 5–8 days after the hot spell. Summer cover crops and mulch help to reduce this physiological disease.

Spraying with 4 kg of calcium chloride in 1000 L of water during the period from early July to mid–August has been demonstrated to reduce this disorder on prunes. Three sprays, 10–12 days apart, should be applied.

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## Thinning Notes

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### Thinning Plums

In recent years, the market demand for larger fruit has placed more importance on fruit thinning, pruning and irrigation. Japanese plums require systematic fruit thinning; otherwise fruit size will be small and a biennial cropping will ensue. European plums grown for fresh market also require thinning in the years of heavy fruit set. Inadequate fruit thinning will result in production of under sized plums and, at times, fruit ripening on overloaded trees will be delayed.

Start thinning near the end of June drop (early–mid June) when you can determine which fruits will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Fruit size thinning is preferred to conventional space thinning. Size thinning selectively removes small, weak, blemished or diseased fruits regardless of spacing of the fruits on the branches. The end result should be proper sizing of the fruit remaining on the tree.

# 11. Tree Nuts

## Walnut Calendar

Read the label and follow all safety precautions.  
For dilute spraying, refer to Guide to Spraying Tree Fruits, page 12.

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>1<sup>st</sup> Pistillate Flower</b>			
Walnut blight	• Clean Crop Copper	4.00 kg	Apply in sufficient water to ensure complete coverage. Do not apply more than 4 times per season. Do not apply after husks split. Do not apply within 40 days of harvest.
<b>Summer Sprays</b>			
Codling moth Filbert worm Walnut husk fly	• Guthion 50 WP	2.25 kg	To time sprays accurately, monitoring of the pest is recommended. Do not apply after husks split. Do not use Guthion in back pack or home garden type sprayers. <i>*Minimum period for reentry is 48 hrs. See product label for specific reentry requirements and precautions.</i>
Walnut blight	• Clean Crop Copper	4.00 kg	Apply in sufficient water to ensure complete coverage. Do not apply more than 4 times per season. Do not apply after husks split. Do not apply within 40 days of harvest.

## Filbert/Hazelnut Calendar

Diseases and Insects	Materials	Amount per Hectare	Comments
<b>Dormant</b>			
Eastern Filbert blight	• Guardsman Copper oxychloride 50	3.00 kg	Apply prior to bud break. Apply in sufficient water volume to ensure thorough coverage.
<b>Post-Harvest</b>			
Eastern Filbert blight	• Guardsman Copper oxychloride 50	3.00 kg	Apply prior to fall rains and when 75% of leaves have fallen. Apply in sufficient water volume to ensure thorough coverage.

# 12. Weed Management for Fruit Crops

## Principles of Integrated Weed Management

Integrated Weed Management (IWM) uses all available weed control options in the best possible way to manage weed populations. Such options include crop rotation, cover crops, intercropping, manipulation of nitrogen fertility, planting pattern, tillage systems, critical period of weed control, alternative weed management strategies in conservation tillage systems and economic thresholds.

All these practices are components of an IWM system and none of these control measures on their own can be expected to provide acceptable levels of weed control. Therefore, instead of relying on only one particular method of weed control, an IWM system uses a combination of methods to control weeds. By following the principles of an IWM system you can reduce the use of herbicides and, at the same time, provide optimum economic returns.

### Crop Rotation

Crop rotation involves alternating different crops in a systematic sequence on the same land. It is an important strategy for developing a sound, long-term weed control program. Weeds tend to thrive with crops of similar growth requirements as their own and cultural practices designed to contribute to the crop may also benefit the growth and development of weeds. Monoculture — that is growing the same crop in the same field year after year — results in a build-up of weed species adapted to the growing conditions of the crop. When diverse crops are used in rotation, weed germination and growth cycles are disrupted by variations in cultural practices associated with each crop (tillage, planting dates, crop competition).

### Cover Crops

The inclusion of cover crops such as rye, red clover, buckwheat and oilseed radish, or overwintering crops like winter wheat or forages in the cropping system, can suppress weed growth. Fast growing crops, or crops exhibiting allelopathic properties, can also suppress weeds. Highly competitive crops may be grown as short duration “smother” crops within the rotation. Additionally, cover

crop residues on the soil surface will suppress weeds by shading and cooling the soil. When choosing a cover crop, always consider how the cover crop will affect the succeeding crop.

### Intercropping

Intercropping involves growing a smother crop between rows of the main crop. Intercrops are able to suppress weeds. However, the use of intercropping as a strategy for weed control should be approached carefully. The intercrops can greatly reduce the yields of the main crop if competition for water or nutrients occurs.

### Nitrogen Fertility

Nitrogen fertilizer can affect the competition between crops and weeds and in the subsequent crops. For example, nitrate is known to promote seed germination and seed production in some weed species. Nitrogen fertilization may result in increased weed growth, instead of increased crop yield. Selective placement of nitrogen in a band can favour the crop over the weed. Using legume residues instead of chemical nitrogen fertilizer to supplement the nitrogen needs of the crop can enhance weed suppression. Legume residues release nitrogen slowly with less stimulation of unwanted weed growth.

### Planting Patterns

Crop population, spatial arrangement and the choice of cultivar (variety) can affect weed growth. For example, studies show that narrow row widths and a higher seeding density reduces the biomass of later-emerging weeds by reducing the amount of light available for weeds located below the crop canopy. Similarly, fast growing cultivars can have a competitive edge over the weeds.

### Tillage System

Tillage systems alter the soil seedbank dynamics and depth of burial of weed seeds. Studies have found that almost 75% of the weed seedbank was concentrated in the upper 5 cm of soil in no-till fields. In the moldboard plow system however, the seedbank is more uniformly distributed over depth. Other conservation tillage systems are intermediate to these two systems.

Weed seedling emergence is often more uniform from shallowly buried weed seeds and may result in better weed control. Weed seeds closer to the soil surface are more likely to be eaten or damaged by insects, animals, other predators and disease causing organisms.

### **Critical Period of Weed Control**

The critical period of weed control is an important concept in IWM systems. This period has been defined as an interval in the life cycle of the crop when it must be kept weed-free to prevent yield loss.

This concept helps in determining the most effective time for non-residual postemergent herbicide applications, and reduces the use of season-long residual herbicides, and unnecessary late applications of herbicides. The critical periods are defined relative to a crop growth stage to account for soil, weather and seasonal variations. The critical period is based on a yield loss of less than 5% due to weed interference. In other words, the crop has to be weed-free during these stages to prevent a yield loss of more than 5%.

If weeds have been controlled throughout the critical period, the weeds which emerge later will not affect yield and can be controlled prior to harvest with a harvest aid to burn down the weeds and desiccate the crop.

**Season-long weed control is not necessary.**

### **Herbicide Band Applications**

Alternative methods of weed control are available for all tillage systems. Studies show that banding herbicides increases profitability. For example, selective application of herbicides in 30 cm bands on 76 cm wide corn rows represented an approximate 60% reduction in total herbicide applied into the environment. When complemented with inter-row cultivation, weed control and crop yields were maintained with lower herbicide costs.

### **Economic Thresholds**

Weed economic thresholds help in determining if weed density and interference is sufficient to justify control measures — that is if the yield loss avoided is greater than the cost of weed control.

The time at which weeds emerge relative to the crop is a major determinant of yield loss. Early weeds that emerge at the same time as the crop cause more yield loss than weeds emerging after the crop is established. For example, economic threshold studies conducted with redroot pigweed, ragweed and barnyardgrass found that the time of weed

emergence in relation to the crop stage is more important than weed density when evaluating weed control options.

Critical periods and economic thresholds however do not apply in the same way to weeds such as black nightshade, which may reduce the quality of the crop. In such cases the economic threshold may be zero.

**Crop yield loss depends on the relative time of weed seedling emergence.**

## **Mechanical Methods of Weed Control**

### **Preemergent or "Blind" Harrowing**

Blind harrowing consists of waiting until after the crop has been planted, the seed is sprouted and the shoot is about to emerge. At this crucial time, the field is harrowed to kill the small weed seedlings that have already sprouted. The crop will emerge shortly afterwards, having gained a head start on the next generation of weeds. When properly carried out, this method can be most effective in controlling annual weeds in large seeded crops.

In cereals, this blind harrowing often provides adequate control of annual broadleaf weeds. In row crops, it can be used to keep weeds down until the crop plants are large enough to withstand other mechanical control methods. Any type of light harrow can be used. Blind harrowing must not be done on crops underseeded with grass or legumes.

### **Weeder Harrow**

A weeder harrow has spring tines that are gentle enough not to harm the cultivated crop, while uprooting or covering the smaller annual weeds. Therefore, the relative size of the cultivated plants and the weeds is important. Weeder harrowing is most successful when used as a "blind harrowing". There are specially— designed weeder harrows to use on field crops at various stages of development. These can be used most effectively on field vegetables, corn, soybeans and cereals.

### **Rotary Hoe**

The rotary hoe has "fingers" that lift and mix the soil, uprooting small weeds. It is important to work at 10–20 km/hr for satisfactory results. Best results are obtained during late morning or afternoon hours when the hot sun can dry out the uprooted weeds. Also, crop plants tend to be more pliable at this time and injury is reduced.



Rotary hoes tend to cause less crop damage than harrows. They are also effective in breaking up a soil crust and mixing surface-applied herbicides into the soil, which will improve the weed control. On light soils or under loose soil conditions, be careful to keep the rotary hoe working at a shallow depth.

### Inter-Row Cultivation

Shallow inter-row cultivation, or scuffling of row crops, uproots small weeds and cuts off larger weeds. There are various types of equipment you can use but, if using shovels, allow for up to 50% overlap for thorough weed control. Use shields to protect small crops.

Row cultivation can be used profitably when applying herbicides. The herbicide may be more effective and the amount of herbicide used can be reduced, particularly with band applications. To provide adequate weed control in long-season crops, such as corn, scuffling will probably have to be done more than once. The first cultivation is the most crucial since weeds that escape this pass usually grow to maturity. Here again the relative size of the crop to the weeds is important and probably the limiting factor in achieving 100% success. Use blind harrowing, weeder harrows and rotary hoes first, so that inter-row cultivators produce good results.

### Mowing

Mowing or cutting weeds may control weeds in orchards, roadsides, lawns, etc. Harvesting hay or cereal crops also helps control weeds. Mowing cereal stubble in early August can reduce weed growth and weed seed production, especially if the cereal had been underseeded to another crop, such as red clover, to compete with the new weed growth.

The best time to mow perennial weeds is usually at the bud stage when root reserves are low and before seed set. Note that if a herbicide application is planned for later in the season, leave adequate time for weed regrowth after mowing. For more information, see individual crop sections.

## Herbicides for Fruit Crops

### Introduction

Read these pages with the recommendations given in this publication. Additional information on use, toxicity and safety precautions is given here. With a few exceptions the chemicals are listed under their common (generic) rather than their trade or product name. See Table 13-1, *Pesticides Used on Fruit Crops in Ontario*, to determine the corresponding common name for a particular trade name. For example, Table 13-1 indicates that the trade name LON-

TREL has a common name of clopyralid; notes on LON-TREL will be listed under clopyralid in this section.

**Trade names and common names of herbicides are cross-referenced in Table 13-1, *Pesticides Used on Fruit Crops in Ontario*, page 206.**

### 2,4-D

**Trade Names:** 2,4-D AMINE, ESTEMINE (AMINE), ESTASOL (L.V. ESTER). **Chemical Family:** Phenoxy. **Crop and/or Non-Crop Registrations:** Cereals, turf, pastures, non-crop land, asparagus, field corn, cranberries, raspberries, strawberries, bearing fruit trees including apple, pear, peach, plum, apricot and cherries, water weeds and brush. **Sensitive Weeds:** Most broadleaf weeds, and brush. **Uptake and Translocation:** Readily absorbed through leaves or roots. Translocated primarily in phloem with the sugars but can also move with water in the xylem. Accumulation is primarily in the young, rapidly growing meristematic regions of roots or shoots. **Basis of Selectivity:** Differences in interception, penetration, translocation, metabolism and sensitivity of active sites lead to greater activity on broadleaf weeds compared to grasses. **Application Methods:** Postemergence (broadleaf weeds), stem-foliage or stem-basal (brush). **Residual Activity:** Half-life in soil is usually not longer than 1 or 2 weeks during the growing season due to rapid decomposition by soil micro-organisms. **Unique Characteristics:** All weeds are more easily killed when growing rapidly in moist soil. Unfortunately, some broadleaf crops, garden and ornamental plants are as sensitive to 2,4-D as many weeds and only a trace of the chemical as spray drift, vapour drift or contaminant in soil or water may cause serious damage. Even crops that can be sprayed safely can be sensitive at some stages of growth or at excessive application rates; thus label precautions should be followed carefully. Amines and esters are the most common formulations of 2,4-D. The esters are the most active and can be used at the lower rates and for brush control. Since vapour drift is a potential problem with the ester formulations, only the amines should be used on lawns, or near gardens or susceptible crop areas. Low-volatile esters can be used by agriculturists or licensed applicators in areas where risk of damage to sensitive non-target vegetation is low. Recommendations are on the basis of acid equivalent; commercial products differ in their content of acid equivalent, which must be considered in determining the amount of product to use.

### 38-F DRIFT RETARDANT

**Type of Adjuvant:** Drift-control agent. **Chemical Composition:** Polyacrylamide polymer 32%. **Registered**

**Uses:** For non-crop use with most water-soluble, emulsifiable or wettable-powder formulations of pesticides. **Benefit:** Drift control. **Mode of Action:** When tank mixed with a pesticide, 38-F reduces drift by materially reducing fines resulting from shear. **Mixing:** Add 38-F at a steady rate into the mixing tank at the point of maximum agitation. In most cases, this is where the liquid level in the tank is at or just below the injection point of the filling water. After the last tank addition has been made, allow the mixing to continue for a few minutes before using. Refer to product label for more information.

## ADJUVANTS

(See AGRAL 90, AF-SURF, ASSIST OIL CONCENTRATE, CITOWETT PLUS, COMPANION, DEFOAMERS, DRIFT-CONTROL AGENTS, ENHANCE, FIGHTER F, HALT, KORNOIL, KORNOIL CONCENTRATE, LI700, MERGE, NALCONTROL, SIDEKICK, SURE-MIX, SYLGARD 309, SPRAY ADJUVANT DEFOAMER).

## AGRAL 90

**Type of Adjuvant:** Non-ionic surfactant. **Chemical Composition:** Nonylphenoxy polyethoxyethanol 90%. **Registered Uses:** For use with diquat, paraquat, glyphosate, imazethapyr, rimsulfuron, nicosulfuron/ rimsulfuron and for washing sprayer tanks and equipment. **Benefit:** Improves chemical effectiveness. **Mode of Action:** It is a wetting and spreading agent that improves coverage of spray mixes. **Mixing:** Use 250–1000 mL/1000 L of spray as specified on label. Will mix with all types of water. Add AGRAL 90 to the spray mixture and agitate thoroughly. **Unique Characteristics:** Do not exceed the recommended rates of AGRAL 90 as too much wetting agent can lead to loss of spray due to excessive run-off.

## AG-SURF

**Type of Adjuvant:** Non-ionic surfactant. **Chemical Composition:** Nonylphenoxy polyethoxyethanol 92%. **Registered Uses:** For use with glyphosate, imazethapyr and fluazifop-p-butyl. **Benefit:** Improves chemical effectiveness. **Mode of Action:** It is a wetting and spreading agent that improves coverage of spray mixtures. **Mixing:** For use with ROUNDUP: when applying the 2.5 L/ha of water, add AG-SURF at 0.5% (0.50 L/100L water) to maintain adequate surfactant concentration. For use with ROUNDUP to control annual grasses and broadleaf weeds for minimum or zero-till: use 350 mL/ha plus ROUNDUP at 1.1 L/ha in 50–100 L/ha of clean water. For use with FUSILADE 250EC: add 100 mL of AG-SURF for each 100 L of spray solution (0.1%). An anti-foaming agent may be required to reduce foaming. **Unique Characteristics:** Do not exceed recommended

rates of AG-SURF, as too much may reduce the effectiveness of the herbicide due to excessive run-off. Consult product label for full directions.

## AMITROLE

**Trade Name:** AMITROL-T, AMITROL 240. **Chemical Family:** Triazole. **Crop and/or Non-Crop Registrations:** Preplant in corn, soybeans and white beans. Post-harvest in corn, soybeans, white beans, grain, peas, alfalfa and clover. **In-season weed control in apples.** Use in shelterbelts, non-crop areas, marshes and ditches. Spot treatment in pastures. **Sensitive Weeds:** Many annual and perennial broadleaf weeds and grasses including quack grass, dandelions, Canada thistle, sow-thistle, poison-ivy, poison-oak, toadflax, milkweed, hoary cress, leafy spurge, horsetail, cattail, honeysuckle, locust, ash and sumac. **Uptake and Translocation:** Absorbed by foliage and roots. Translocates well in xylem and phloem. Accumulates in growing regions of plant. **Basis of Selectivity:** Resistant plants metabolize amitrole more rapidly than sensitive plants and may have lower uptake as a result of leaf structure that reduces wetting and penetration. **Application Methods:** Foliar postemergence application to actively growing plants. Good coverage is essential. If weeds are mature, it is advisable to cut them and then spray the regrowth. Do not disturb treated plants for at least 2 weeks after application. Do not make post-harvest application after Oct. 1. For control of quack grass and Canada thistle, apply in spring or fall to actively growing plants 15–20 cm tall: wait 10–14 days and then plough or disk. **Residual Activity:** Approximately 2–4 weeks in moist, warm soil. **Unique Characteristics:** Most crops are sensitive if contacted. Poor results may occur if spray coverage is inadequate, if plants are drought stressed or overmature, or if heavy rains fall within 6 hours after application. Do not graze or plant to grain, peas, alfalfa or clover for 8 months after treatment. Do not graze spot-treated areas in pastures for 6 months following treatment.

## AQUASHADE

**Chemical Family:** Water-soluble dyes. **Crop and/or Non-Crop Registrations:** Contained golf course, farm and industrial ponds, fountains and aquariums. **Sensitive Weeds:** Filamentous algae and certain aquatic weeds. **Uptake and Translocation:** The dye filters wavelengths of sunlight reducing the light intensity. **Application Methods:** May be added in a concentrated form from the shoreline or diluted form for larger areas. It is recommended to make the application early in the growing season before algae and weed growth develops. Mechanical removal of heavy vegetation is recommended before applying Aquashade if fish are present in the pond. **Residual Activity:** The effect lasts as long as the water keeps its blue

color. Additional Aquashade can be applied when the color of the water fades or when the first new algae and weed growth is noticed. **Unique Characteristics:** It has no direct chemical action and will therefore not harm fish.

## ASSIST OIL CONCENTRATE

**Type of Adjuvant:** Mineral oil/surfactant (non-herbicide). **Chemical Composition:** 83% paraffin base mineral oil plus 17% surfactant blend. **Registered Uses:** ASSIST OIL CONCENTRATE is registered for use with sethoxydim, BASAGRAN, bentazon/atrazine and atrazine. **Benefit:** The use of ASSIST results in improved postemergence activity and a greater degree of consistency under varying environmental conditions. ASSIST will also aid in providing a faster weed kill. **Mode of Action:** Reduces the evaporation of spray droplets on the leaf surface leading to a longer period for penetration. Improves penetration through the leaf cuticle layer. ASSIST also aids in spreading a spray droplet on the leaf surface so that it covers a greater surface area. **Mixing:** Half-fill the spray tank with water and begin agitation. Add the desired amount of herbicide and continue filling. Add ASSIST last. After filling, continue agitation. Agitate thoroughly after any stoppage in spraying. **Unique Characteristics:** May cause increased temporary topical burn to crop plants under hot, humid weather conditions.

## BENTAZON

**Trade Names:** BASAGRAN FORTE, BASAGRAN. **Chemical Family:** Benzothiadiazine. **Crop and/or Non-Crop Registrations:** BASAGRAN FORTE AND BASAGRAN: Peas, flax, soybeans, dry beans, faba beans, corn. BASAGRAN also registered for peanuts, lima beans, snap beans, highbush blueberry, new plantings of apples, apricots, cherries, peaches, pears and turf. **Sensitive Weeds:** Annual broadleaf weeds including hairy nightshade, lamb's-quarters, redroot pigweed, low cudweed, purslane, common ragweed, wild radish, Russian thistle, hairy galinsoga, corn spurry, bird rape, flower-of-an-hour, buttercups, common groundsel, jimsonweed, giant ragweed, velvetleaf, lady's-thumb, wild mustard, cocklebur, stinkweed, shepherd's-purse and common chickweed. Triazine-tolerant biotypes of lamb's-quarters, redroot pigweed, common ragweed and common groundsel are also controlled. Top growth of Canada thistle and nut sedge are controlled. Field bindweed may be suppressed by 2 applications applied 10 days apart. **Uptake and Translocation:** Taken up through the foliage. Not translocated. **Basis of Selectivity:** Metabolism by tolerant species. **Application Methods:** Postemergence when weeds are small and actively growing. Apply in 100–400 L water/ha. Crop must be in a tolerant growth stage (see specific recommendations on label). Thorough spray coverage is nec-

essary. Use flat fan nozzles tilted 45° forward. Use ASSIST OIL CONCENTRATE with BASAGRAN. The ASSIST rate should be reduced under hot, humid conditions. CIT-OWETT PLUS may replace ASSIST on peas. Liquid ammonium sulphate or 28% urea ammonium nitrate may be added to BASAGRAN FORTE or BASAGRAN for improved and more consistent control of velvetleaf and lamb's-quarters in soybeans only. PINNACLE may be tank mixed with BASAGRAN FORTE or BASAGRAN for improved pigweed and lamb's-quarters control in soybeans only. BASAGRAN FORTE does not require additional adjuvants. BASAGRAN FORTE is not registered for aerial application. BASAGRAN is registered for aircraft application for soybeans, dry and snap beans. **Residual Activity:** Essentially none. **Unique Characteristics:** Corn and turf are tolerant at all stages of growth. Bentazon is not volatile. Temporary crop injury can be expected if bentazon is applied during hot, humid weather or if crop is stressed (flooding, drought, cold). Cool weather or drought may delay control. Rainfall within 6–8 hrs. after application may reduce effectiveness. Since there is no residual activity, a new flush of weeds may emerge after the first flush has been controlled.

## CLOPYRALID

**Trade Names:** LONTREL, LONTREL 360, TRANS-LINE. **Chemical Family:** Pyridine. **Crop and/or Non-Crop Registrations:** Strawberries, highbush blueberries, new and bearing apples, cranberries, sugar beets, rutabagas, cole crops (cabbage, cauliflower, broccoli, asian cole crops), control of broadleaf weeds in rights-of-way (hydro, railroad, communication lines, pipelines) and associated stations, industrial manufacturing sites, storage sites and roadsides, airports, military bases and low maintenance, rough-turf areas, rangeland, grass pasture and balsam fir Christmas tree stands or plantations. **Sensitive Weeds:** Will control or suppress certain annual and perennial weeds including Canada thistle, goldenrod, ox-eye daisy, tufted vetch, sheep sorrel, dandelion and wild buckwheat, scentless chamomile, groundsel, ragweed, coltsfoot and spotted knapweed. **Uptake and Translocation:** Rapidly absorbed by foliage and translocated readily throughout the plant via both xylem and phloem systems. Clopyralid is distributed throughout the plant to the meristem. **Basis of Selectivity:** Effects on nucleic acid metabolism and growth are not observed in grasses and other tolerant species. **Application Methods:** Postemergence as a broadcast or selective foliar. **Residual Activity:** Half-life in soil is less than 30 days under conditions that are favourable for microbial degradation. Little to no residual activity. **Unique Characteristics:** Clopyralid has little to no activity on woody vegetation, except woody species of the legume family.



## COPPER CITRATE AND GLUCONATE

**Trade Name:** ALGIMYCIN PLL-C. **Chemical Family:**

Chelates of copper gluconate and copper citrate. **Crop and/or Non-Crop Registrations:** Algae control in wholly enclosed farm, fish and fire ponds having no outflow beyond the property limits of the user. **Sensitive Weeds:** Most algae including Spirogyra, Ulothrix, Cladophora, Chara and Nitella. **Uptake and Translocation:** No information available. **Basis of Selectivity:** Non-selective. **Application Methods:** Available as a tablet or a liquid formulation. Apply early in the season where algae is well established and growing vigorously. Apply early in the day as sunlight enhances the effectiveness of the treatment. To ensure even distribution, apply tablet formulation with a hand scoop. Apply liquid directly onto floating mats of algae or inject below surface for algae growing on the bottom of the pond, with a small hand sprayer or backpack sprayer. To avoid oxygen depletion, treat 1/3–1/2 of the water area in a single operation and wait at least 10–14 days between treatments. **Residual Activity:** One application of the tablet formulation of ALGIMYCIN should provide control over the entire year. When using liquid ALGIMYCIN, a second treatment or spot treatment later in the season may be required. **Unique Characteristics:** The tablet formulation is more effective than the liquid formulation for the control of Chara and Nitella. Not for use in public waters or waters that drain into public waters. Do not apply in deep waters. May be toxic to trout and other species of fish. Do not apply directly to crop plants, seedling grasses or non-established ornamental plants, as injury may result. Not for use in potable water systems.

## COPPER ETHANOLAMINE

**Trade Name:** CUTRINE-PLUS. **Chemical Family:**

Mixture of chelates of copper ethanolamines. **Crop and/or Non-Crop Registrations:** Algae control in wholly enclosed farm, fish and fire ponds and fish hatcheries having no outflow beyond the property limits of the user. **Sensitive Weeds:** Microcystis, Oscillatoria, Anabaena, Aphanizomenon, Spirogyra, Cladophora, Vaucheria, Ulothrix, Chara and Nitella. **Uptake and Translocation:** No information available. **Basis of Selectivity:** Non-selective. **Application Methods:** Available as a granular or liquid formulation. Apply early in the day as ample sunlight is required for maximum control. To ensure even distribution of the granular formulation, employ a scoop or dry fertilizer spreader. Use a hand or power sprayer for best distribution of the liquid formulation. To avoid oxygen depletion, treat only 1/3–1/2 of the pond at a time. Allow 1–2 weeks between treatments. **Residual Activity:** One application of granular CUTRINE-PLUS should provide control over the entire season. When using liquid CUTRINE-PLUS, a second treatment later in the season

may be required. **Unique Characteristics:** Not for use in potable waters. Not for use in public waters or waters that drain into public waters. Extremely toxic to fish in soft waters; toxic in hard waters if the maximum recommended concentration is exceeded; if fish are present but water hardness is not known, do not use CUTRINE-PLUS. Treated areas may be used for swimming or fishing immediately after treatment. Water from treated pools may be used to irrigate turf, fairways, putting greens and ornamental plants.

## DEFOAMERS

(See FIGHTER F, HALT, SPRAY ADJUVANT DEFOAMER)

## DICHLLOBENIL

**Trade Name:** CASORON. **Chemical Family:** Benzoni-

trile. **Crop and/or Non-Crop Registrations:** Cranberries, fruit trees, grapes, highbush blueberries, raspberries, container nursery stock, woody nursery stock, shelterbelts and non-crop areas. **Sensitive Weeds:** Most weeds are susceptible to or suppressed by, dichlobenil including perennials, vetch and horsetail. **Uptake and Translocation:** Absorbed by the roots and rapidly translocated upward in the plant. **Basis of Selectivity:** Selectivity is based on physical separation between the dichlobenil vapour layer in the top 5 cm of soil and the established crop roots below this level. **Application Methods:** Applied preemergence to the weeds, preferably in either fall or early spring. **Residual Activity:** May persist and provide weed control for 2–6 months; higher rates and applications following use in previous year(s) may result in soil residues persisting for longer than 1 yr. **Unique Characteristics:** Although applied as a granular herbicide it kills by means of a vapour phase in the top soil profile. Weed roots take up the herbicide as they enter this zone. Do not apply dichlobenil during periods of high soil temperature, since loss of control will result due to volatilization of the herbicide.

## DIQUAT (AQUATIC)

**Trade Name:** REGLONE A. **Chemical Family:** Bipyridylum.

**Crop and/or Non-Crop Registrations:** Aquatic weed control in still or flowing water in ponds, ditches, lakes and canals. **Sensitive Weeds:** Coontail, Canada water weed, pondweeds, milfoil and duckweed. **Uptake and Translocation:** Contact desiccant with limited translocation. **Basis of Selectivity:** None. **Application Methods:** Postemergence. Apply when weeds are visible and are actively growing. It can be applied: with a boat bailer device that injects the chemical below the water surface; sprayed over the water surface; or poured directly from a container onto the surface. **Residual Activity:**

Quickly inactivated by adsorption to soil particles. **Unique Characteristics:** Must be used with and applied on non-turbid water, as the soil particles in muddy water drastically reduce the effectiveness of the material. Apply at dusk. Do not use treated water for swimming or consumption by humans or animals for at least 24 hrs. Do not use water for irrigation for 5 days after treatment. To avoid fish kills caused by oxygen depletion, treat only 1/4–1/3 of the area at a time. Avoid application or drift onto crops, lawns, grazing areas, ornamental plants and other desirable plants.

## DIURON

**Trade Name:** KARMEK. **Chemical Family:** Substituted urea. **Crop and/or Non-Crop Registrations:** Grapes, asparagus, gladioli, industrial sites, right-of-ways. **Sensitive Weeds:** Annual and perennial grasses, pigweed, ragweed, wild carrot and dandelion. Perennial weed control at higher rates in non-crop areas. **Uptake and Translocation:** Most readily absorbed by roots, less so by foliage. Translocated upward in the xylem. **Basis of Selectivity:** Used only in deep-rooted crops that are well established. **Application Methods:** Applied to crops as a preemergence or directed early postemergence spray, preferably before weed growth becomes dense. Better control of emerged weeds is obtained by the addition of a suitable surfactant. In non-crop areas, diuron may be sprayed anytime except when ground is frozen. **Residual Activity:** At lower rates used in crops, residues last about a year and thus applications may be repeated annually. At higher non-crop rates, persistence may be more than 1 yr. **Unique Characteristics:** Shouldn't be used where it is likely to leach or wash into contact with the roots of desirable trees or shrubs.

## DRIFT-CONTROL AGENTS

(See 38-F DRIFT RETARDANT, NALCO-TROL.)

## ENHANCE

**Type of Adjuvant:** Cationic surfactant with an additional non-ionic component. **Chemical Composition:** Mixture of tallow fatty acid amine ethoxylate and nonylphenoxy polyethoxy ethanol. **Registered Uses:** Season-long control of quack grass at low rate of glyphosate. For use with post-emergent applications of imazethapyr in soybeans. **Benefit:** Improves consistency of performance, particularly at high water volumes and under stressful growing conditions. **Mode of Action:** Improves leaf wetting and adhesion; increases overall penetration, resulting in enhanced uptake of glyphosate. **Mixing:** Half-fill the sprayer tank with clean water then add the required amount of glyphosate. While agitating, add the required amount of ENHANCE (0.5 L/ha in 100–200 L/ha of water) and complete filling the sprayer tank with water.

## FIGHTER F

**Type of Adjuvant:** Antifoamer-Defoamer. **Chemical Composition:** Dimethyl-polysiloxane 10%. **Registered Uses:** To control foam in water, oil, fertilizer and pesticide spray mixtures. **Benefit:** Controls foam when mixing sprays, eliminates material waste, provides more accurate metering of agricultural sprays, and eliminates foam overflow at fill site. **Mixing:** To control foam when mixing spray solution, add defoamer either just before or during addition of any other spray adjuvant. To cut existing foam, add defoamer to tank and recirculate solution until foam dissipates.

## FLUAZIFOP-P-BUTYL

**Trade Names:** FUSILADE II, VENTURE 25G. **Chemical Family:** Aryloxy-phenoxypropionate. **Crop and/or Non-Crop Registrations:** FUSILADE II — Flax, canola, soybeans, sugar beets, sunflowers, tobacco, forage legumes (alfalfa, red clover and bird's-foot trefoil), cabbage, broccoli, brussel sprouts, califlower, cucumber, onions, potatoes, rutabagas, tomatoes, **highbush blueberries, raspberries, strawberries**, non-grassy ornamental plants, poplars, shrubs, trees, **apples, apricots, cherries, cranberries, peaches, pears and plums**, forest and ornamental nurseries. VENTURE 25G — canola, alfalfa and soybeans. **Sensitive Weeds:** Annual grass species, volunteer corn, wheat, barley and quack grass. **Uptake and Translocation:** Absorbed primarily by leaves. Translocated to roots and rhizomes. **Basis of Selectivity:** Metabolism by tolerant species. **Application Methods:** Postemergence. Apply when grasses are actively growing, and annual grasses are in the 2- to 5-leaf stage and quack grass is in the 3- to 5-leaf stage. **Residual Activity:** Essentially none. **Unique Characteristics:** Preplant tillage to break up rhizomes will improve control of quack grass. Except as noted on the label, broadleaf herbicides should be applied separately at least 3 days after fluzifop-p-butyl. Do not cultivate for 5 days after applying fluzifop-p-butyl. When plants are stressed (lack of moisture, excessive humidity, low temperature and/or very low relative humidity), fluzifop-p-butyl is less effective. Regrowth by tillering may occur if application is made under any of the above conditions. Since there is no residual activity, a new flush of weeds may emerge after the first flush has been controlled.

## FUMIGANTS

(See METAM SODIUM, METHYL-BROMIDE/CHLOROPICRIN, METHYL ISOTHIOCYANATE/DICHLOROPROPENE, METHYL ISOTHIOCYANATE/DICHLOROPROPENE/CHLOROPICRIN)



## GLUFOSINATE AMMONIUM

**Trade Name:** IGNITE, LIBERTY 200SN. **Chemical Family:** Unique. **Crop and/or Non-Crop Registrations:** IGNITE -Desiccation of dry beans and potatoes; directed applications in apples, grapes, peaches, pears and plums; stale seedbed techniques in asparagus, carrots, lettuce and onions; ground crack application in potatoes. LIBERTY 200SN — Corn hybrids specially developed to be tolerant to Liberty 200SN herbicide. Glufosinate-ammonium tolerant inbred lines grown for seed corn production. **Sensitive Weeds:** Non-selective —affects all actively growing green plants; regrowth of perennial species may occur. **Uptake and Translocation:** absorbed through foliage; minimal translocation — dependent on application rate and species treated. **Basis of Selectivity:** IGNITE — All green plant tissue is sensitive; safe on mature (non-green) bark of woody plants. LIBERTY 200SN — All green plant tissue is sensitive except for field corn and seed corn plants that have been specially developed to be tolerant. **Application Methods:** IGNITE — Post-emergence; broadcast or directed spray to avoid contact with leaves or green bark of desirable plants; thorough coverage of the plant tissue to be controlled is essential. LIBERTY 200SN — Postemergence, broadcast 1–8 leaf stage. **Residual Activity:** None; there are no cropping or rotational restrictions after application. **Unique Characteristics:** Speed of action is influenced by environmental factors; at cool temperatures, poor moisture and low humidity, speed of action may be reduced. Heavy dew at time of application may reduce control of certain weed species.

## GLYPHOSATE TMS

**Trade Name:** TOUCHDOWN 480. See glyphosate.

## GLYPHOSATE

**Trade Names:** CLEAR-IT 1, CLEAR-IT 2, CLEAR-IT 3, EXPEDITE GRASS & WEED, E-Z-JECT, GLYFOS, LAREDO, RENEGADE, ROUNDUP, ROUNDUP DRY, ROUNDUP L & G, ROUNDUP TRANSORB, TOUCHDOWN 480, VISION, WRANGLER. **Chemical Family:** Amino acid. **Crop and/or Non-Crop Registrations:** GLYFOS, LAREDO, RENEGADE, ROUNDUP, ROUNDUP TRANSORB, WRANGLER — preplant or post-harvest with no cropping restrictions. Preharvest in wheat, barley, soybeans, canola, flax, lentils, peas and forages. TOUCHDOWN 480 for preharvest use in canola, barley, field beans, field peas, soybeans and wheat. Directed applications in ginseng, cherries, grapes, apples, pears, plums and peaches, strawberries as wiper or spot treatment. **Non-crop registrations:** EXPEDITE GRASS & WEED, ROUNDUP — brush control; turf renovation; chemical mowing; directed application in

woody nursery stock, roadsides and shelterbelts. ROUNDUP - asparagus. E-Z-JECT — selective woody brush and tree control. VISION — silvicultural site preparation, conifer release, forest tree plantings, forest tree nurseries. **Sensitive Weeds:** Annual grasses; perennial weeds (quack grass, Canada thistle, sow-thistle, field bindweed, milkweed, cattails, nut sedge, poison-ivy etc.); brush (birch, alder, poplar, raspberry, willow and maple. **Uptake and Translocation:** Absorbed through foliage and translocated throughout the plant. **Basis of Selectivity:** Non-selective for agricultural crops. Conifers are tolerant at some stages but the basis has not been established. **Application Methods:** Postemergence, usually at the bud to bloom stage of growth for most perennial weeds. Canada thistle should be at least in early flower bud, milkweed at flower bud, and bindweed at full flower. Quack grass can be treated in the spring or fall when it is actively growing with at least 3–4 new leaves on each emerged shoot; in the fall, remove crop refuse but do not till prior to application; fall or spring tillage prior to spring application may reduce control; wait at least 3–5 days after application before working the area; for maximum control it is advisable to till before the quack grass turns completely brown. Glyphosate can be applied with boom equipment, knapsack sprayers and high-volume equipment for agricultural and non-crop uses. Backpack mist blowers may be used for silvicultural site preparation and roadside brush control only. Aerial applications may be used for silvicultural site preparation and conifer release only. Can also be applied with selective equipment for non-crop areas, tree plantings, grapes and orchards (See sections "Special Methods of Weed Control" and "Selective Weed Control with Wiper Applicators"). Regardless of method of application, do not allow herbicide solution to contact green foliage or green bark of crop or other desirable plants; remove all suckers from the trunks of desirable trees before spraying. **Residual Activity:** None: crops can be planted or seeded directly into treated areas following application. Other herbicides are required to control weeds emerging after the application. **Unique Characteristics:** Rainfall within 6 hrs. after application or heavy frost within 24 hrs. may reduce control. ROUNDUP TRANSORB is rainfast as soon as 4 hrs. after application.

## GLYPHOSATE/GLUFOSINATE AMMONIUM

**Trade Name:** ROUNDUP FASTFORWARD PRE-SEED, ROUNDUP FASTFORWARD PREHARVEST. **Chemical Family:** Amino acid/Unique. **Crop and/or Non-Crop Registrations:** ROUNDUP FASTFORWARD PRESEED — Preplant treatments with no cropping restrictions. ROUNDUP FASTFORWARD PREHARVEST — Preharvest treatments in wheat, dry-beans, canola, flax, peas, and lentils. **Sensitive Weeds:**

Annual grass and broadleaf weeds and many perennials such as quack grass and Canada thistle. **Translocation:** Absorbed through foliage and translocated throughout the plant. **Basis of Selectivity:** Non-selective for agricultural crops. **Application Methods:** Postemergence to actively growing weeds using boom equipment (see glyphosate note for more information). **Residual Activity:** None: Crops can be planted directly into the treated areas following application. **Unique Characteristics:** Glyphosate/glufosinate ammonium provides quicker burndown of green vegetation than glyphosate alone. Rainfall within 2 hrs. after application or a heavy frost within 24 hrs. may reduce control.

## HALT

**Type of Adjuvant:** Defoamer. **Chemical Composition:** Silicone base, neutral. **Registered Uses:** To reduce foaming when preparing herbicide spray mixes. **Benefit:** The reduction of foaming allows faster tank fill-ups, ensures correct fill volumes, reduces the possibility of chemical overflow and gives more accurate herbicide application. **Mixing:** Add 7 mL/500 L of spray mix. May be added to spray tank during filling to prevent foaming, or after to cut foam. **Unique Characteristics:** May be used with any herbicide unless contraindicated on the label.

## LI700

**Type of Adjuvant:** Non-ionic surfactant and pH Adjuster/Acidifier. **Chemical Composition:** Phosphatidylcholine, methylacetic acid and alkyl polyoxyethylene ether 80%. **Registered Uses:** As a penetrating surfactant; as a pH adjuster/acidifier; for use with glyphosate products such as ROUNDUP, LAREDO, RENEGADE, WRANGLER and VISION. Alkaline water, even mildly alkaline, causes alkaline hydrolysis or degradation of many pesticides. Some chemicals degrade in less time than it takes to put out a tank of spray. When mixed with spray solutions, LI700 neutralizes or slightly acidifies the pH-sensitive products in the spray tank. Add LI700 before adding the pesticide. **Benefit:** Improves chemical effectiveness. **Mixing:** As a penetrating surfactant: Use 5 L of LI700/1000 L spray mixture or 500 mL of LI700/100 L spray mixture. As a pH adjuster/acidifier: Highly alkaline water, (pH 8 or higher), Use: 625 mL–1.25L LI700/1000 L water mixture.

## LINURON

**Trade Name:** AFOLAN F, LINURON 480, LOROX DF, LOROX L. **Chemical Family:** Substituted urea. **Crop and/or Non-Crop Registrations:** Corn, soybeans, carrots, celery, dill, parsnips, potatoes, asparagus, wheat, oats, barley, gladioli, fruit trees. **Sensitive Weeds:**

Annual weeds such as barnyard grass, common chickweed, corn spurry, crab grass, velvetleaf, fall panicum, foxtail, goosefoot, goose grass, groundsel, knotweed, lamb's-quarters, redroot pigweed, purslane, common ragweed, shepherd's-purse, smartweed, stinkweed, wild buckwheat, witch grass, wormseed mustard, triazine-resistant weeds; seedlings only of dandelion, plantain and sow-thistle.

**Uptake and Translocation:** Readily absorbed through roots, less so through foliage; translocation primarily upwards in xylem. **Basis of Selectivity:** Differential metabolism often coupled with differential uptake and translocation. **Application Methods:** Preemergence, postemergence, directed postemergence, pre plus postemergence. **Residual Activity:** Does not pose a problem for subsequent crops since phytotoxic residues from applications at agricultural rates disappear within 4 months. **Unique Characteristics:** Do not use on sandy or coarse-textured soils having less than 2% organic matter. If unusually heavy rains follow application, severe injury may occur to corn, soybeans, carrots and potatoes.

## MCPB/MCPA

**Trade Name:** CLOVITOX PLUS, TROPOTOX PLUS. **Chemical Family:** Phenoxy/phenoxy. **Crop and/or Non-Crop Registrations:** Seedling white, ladino, alsike or red clovers direct seeded or underseeded in wheat, oats, barley, rye, pastures, field corn, peas, grapes. **Sensitive Weeds:** Small emerged mustards, stinkweed, ragweed, lamb's-quarters, redroot pigweed, shepherd's-purse, volunteer rapeseed, wild radish, hemp-nettle, annual sow-thistle; top-growth control of bull thistle, Canada thistle, curled dock, plantain, perennial sow-thistle, field bindweed, horsetail, buttercup. **Uptake and Translocation:** Absorbed through the foliage and readily translocated, especially to the growing points. **Basis of Selectivity:** MCPB is not directly toxic to plants. Susceptible weeds convert MCPB to MCPA. **Application Methods:** Postemergence. In cereals, clovers and peas, apply as an overall spray. In corn, apply with drop pipes after the corn reaches 45 cm before the beginning of tasselling. Apply to pastures after grazing or cutting.

## MERGE

**Type of Adjuvant:** Surfactant/solvent. **Chemical Composition:** 50% surfactant blend plus 50% solvent (petroleum hydrocarbons). **Registered Uses:** For use with sethoxydim. **Benefit:** Improves chemical effectiveness and provides a greater degree of consistency under varying environmental conditions. **Mode of Action:** Improves spreading of spray droplets on the leaf surface and increases contact surface area. Improves penetration of herbicide through the leaf cuticle layer. Acts as a protectant against photodegradation of sethoxydim by UV light. **Mixing:**

Half-fill spray tank with water, start agitation. Add required amount of herbicide and continue agitation. Add MERGE, along with remaining water, last to the tank. Agitate thoroughly after any stoppage in spraying. **Unique Characteristics:** May cause temporary topical burn to crop plants under hot, humid weather conditions.

### METAM SODIUM

**Trade Name:** VAPAM **Chemical Family:** Thiocarbamate. **Crop and/or Non-Crop Registrations:** Field and greenhouse seedbeds. **Field-replant sites of fruits, vegetables, tobacco, ornamentals and forest-tree stock.** **Sensitive Weeds:** Most scarified weed seeds and freshly vegetative parts including rhizomes and germinating seedlings. **Basis of Selectivity:** Most plant parts are sensitive. Crops are not planted until all fumigant has dissipated from the soil. With moisture, methyl isothiocyanate gas is released, which kills most scarified seeds and fleshy vegetative parts including rhizomes and germinating seedlings. **Application Methods:** Apply uniformly using injectors, water or other incorporation tools to carry the product to the desired soil depth. May be applied via the irrigation system. No gas-proof cover is required unless the soil is very porous, however, a sprinkler application of water should be used to provide a surface "water seal". **Residual Activity:** 10–40 days depending on soil temperature and the amount of organic matter present in the soil. Persistence is greatest at low temperatures and high levels of organic matter. Planting may take place 12–16 days after the treatment and following a lettuce-seedling bioassay that indicates no injury. **Unique Characteristics:** Also controls nematodes, soil fungi and soil insects. All traces of toxic gases must be dissipated from the treated soil before planting or plant injury may occur.

### METHYL BROMIDE/CHLOROPICRIN

**Trade Name:** TERR-O-GAS 67. **Chemical Family:** Organohalogen. **Crop and/or Non-Crop Registrations:** Greenhouse and tobacco seedbeds. Methyl bromide is very poisonous to humans and livestock; only an experienced operator should attempt its use. **Sensitive Weeds:** Gas is toxic to germinating seedlings. **Application Methods:** Formulated as a liquid under pressure, that, when released from the container, forms a gas. Soil must be sealed with a plastic sheet since the gas is highly volatile. Refer to label for detailed directions. **Unique Characteristics:** Methyl bromide gas is highly volatile and highly poisonous to humans and livestock. It may be absorbed by inhalation, ingestion and skin contact. A permit must be obtained from the Ontario Ministry of the Environment each time it is used. Also controls soil insects, nematodes and fungal diseases.

### METHYL ISOTHIOCYANATE/ DICHLOROPROPENE

**Trade Name:** VORLEX PLUS. **Chemical Family:** Thiocarbamate. **Crop and/or Non-Crop Registrations:** Pre-plant treatment in both field and greenhouse soils to be planted to: ornamental plants such as flowers and evergreens; vegetables such as celery, lettuce, beets, tomatoes, eggplant, beans, melons, onions, asparagus and squash; field crops such as tobacco, sugar beets, potatoes, ginseng; small fruits such as strawberries. **Sensitive Weeds:** All growing weed seedlings within the fumigated zone. Non-germinated seeds or established weeds may not be controlled. **Basis of Selectivity:** Non-selective. Gas is toxic to most young, green plant tissues. **Application Methods:** Injected into the soil 15–20 cm deep using special application equipment. The soil surface is sealed by either surface irrigation or physically compacting the soil surface. Cultivation of the fumigated soil after the desired period of time allows the gas to escape. **Residual Activity:** Varies with soil type but usually 4–6 weeks if left undisturbed. Always check the soil for fumigant using the lettuce-seedling bioassay before planting a crop in it. **Unique Characteristics:** Also controls fungal diseases and unencysted nematodes.

### METHYL ISOTHIOCYANATE/ DICHLOROPROPENE/ CHLOROPICRIN

**Trade Name:** VORLEX PLUS CP. **Unique Characteristics:** Chloropicrin provides added disease control to the mixture. See notes on METHYL ISOTHIOCYANATE/ DICHLOROPROPENE.

### METOLACHLOR

See S-METOLACHLOR

### METRIBUZIN

**Trade Names:** CONQUEST A (Available only in CONQUEST co-pack), LEXONE DF, SENCOR 500 F, SENCOR 75 DF, SENCOR SOLUPAK. **Chemical Family:** S-triazine. **Crop and/or Non-Crop Registrations:** Established asparagus, faba beans, potatoes, soybeans, transplant tomatoes, apples, apricots, peaches, cherries, corn and triazine-tolerant canola with trifluralin or with terbacil or with metolachlor on apples, apricots, cherries, plums, peaches and pears. **Sensitive Weeds:** Lamb's-quarters, wild mustard, redroot pigweed, common ragweed, shepherd's-purse, lady's-thumb, velvetleaf, jimsonweed, prostrate pigweed, Russian thistle, yellow wood-sorrel, prickly mallow, chickweed, cocklebur, carperweed, dandelion seedlings, barnyard grass, crab grass, foxtail, fall panicum, witch grass, Johnson grass seedlings and cheat grass. **Uptake and Translocation:** Some uptake through the foliage but the major route is via the roots. Transloca-



tion upwards in the xylem. **Basis of Selectivity:** Degradation by tolerant species. **Application Methods:** Preplant incorporated (potatoes, soybeans, apples, apricots, peaches, cherries, corn, tomatoes and triazine-tolerant canola); preemergence (asparagus, potatoes, soybeans and triazine-tolerant canola); postemergence (potatoes, tomatoes, corn and triazine-tolerant canola). **Residual Activity:** Varies with the climate. At normal-use rates the half-life is 1–2 months. **Unique Characteristics:** Heavy rainfall following application may cause crop damage. Some varieties of potato, soybean and tomato are less tolerant than others. Triazine-resistant weeds are not controlled. Do not use on muck soils.

## MINERAL OIL/SURFACTANT (NON-HERBICIDAL)

(See ASSIST OIL CONCENTRATE, CHARGE OIL CONCENTRATE, KORNOIL CONCENTRATE, XA OIL CONCENTRATE)

## NALCO-TROL

**Type of Adjuvant:** Drift-control agent. **Chemical Composition:** Polyvinyl polymer. **Registered Uses:** For use with 2,4-D ester or amine, picloram, paraquat, simazine or dicamba for weed or brush control in non-crop land. **Benefit:** Reduces drift, improves canopy penetration and foliage coverage. **Mode of Action:** Reduces spray break-up and thus the number of fine, driftable droplets. **Mixing:** Use 3–1000 mL/1000 L, depending on pressure, height and nozzle type. Add water and, while agitating, add NALCO-TROL before adding liquid herbicides. Add wettable-powder herbicides to water and ensure dispersion before adding NALCO-TROL. **Unique Characteristics:** Product is extremely slippery; care should be taken when working on spray equipment and following a spill.

## NAPROPAMIDE

**Trade Names:** DEVRINOL 50 DF, DEVRINOL 50W, DEVRINOL 10G. **Chemical Family:** Amide. **Crop and/or Non-Crop Registrations:** Asparagus, cole crops (cabbage, broccoli, cauliflower, Chinese broccoli, Chinese mustard greens, Chinese Nappa cabbage, Chinese radish), garlic, kohlrabi, peppers, pumpkin, squash, fuzzy squash, rutabagas, tomatoes, tobacco, raspberries, blackberries, cultivated lowbush blueberries, established highbush blueberries, boysenberries, cranberries, loganberries, newly planted or established strawberries, apples, grapes, peaches and pears, newly transplanted or established ornamentals, woody nursery stock, forest tree stock and container-grown ornamentals (see label for species). **With simazine or with terbacil on new plantings of apples, apricots, cherries, plums, peaches and pears.** **Sensitive Weeds:** Many annual weeds including crab grass, barn-

yard grass, annual bluegrass, foxtails, sandbur, wild oats, goose grass, chickweed, groundsel, redroot pigweed, lamb's-quarters, purslane, prostrate knotweed, pineappleweed and prickly lettuce. **Uptake and Translocation:** Absorbed through the roots of germinating weeds. Translocated upward through seedling. **Basis of Selectivity:** Metabolized by tolerant species. Root growth of germinating seedlings is inhibited. Established plants are not affected due to placement selectivity. **Application Methods:** May be applied preplant incorporated using water as the carrier. Incorporation should be uniform, and to a chemical depth of 2.5–5 cm, using irrigation or proper incorporation equipment (e.g., tandem discs or field cultivator with sweep teeth) followed by a levelling device. On established crops, apply to a weed-free soil surface and irrigate in if no rainfall occurs within 7 days after application in spring or fall, or within 2 days after application in summer; irrigate with sufficient water to wet the soil to a depth of 5–10 cm (approximately 7 mm of rain). For post-plant application in tobacco, apply in 25 cm band over the row. Cross-disc or cross-plough after harvest to dilute soil residue before planting cover crop. **Residual Activity:** Provides season-long weed control if properly incorporated. Deep ploughing will minimize any carryover effect. **Unique Characteristics:** Will not control germinated weeds. Resists leaching. To avoid injury to crops not registered for use with napropamide, do not plant until 12 months after the last napropamide application.

## PARAQUAT

**Trade Name:** GRAMOXONE. **Chemical Family:** Bipyridylum. **Crop and/or Non-Crop Registrations:** Apples, apricots, cherries, currants, gooseberries, grapes, highbush blueberries, peaches, pears and plums established more than 1 yr; blackberries, loganberries and red raspberries; inter-row spraying in strawberries; stale seed-bed technique for vegetables and field crops; inter-row directed chemical weeding for vegetable fields and established nursery crops; asparagus; potatoes; established alfalfa and bird's-foot trefoil; pasture renovation; zero tillage corn; conifer control; turf renovation; chemical mowing weed control in non-crop land; aquatic weed control. **Sensitive Weeds:** Non-selective — affects all green plants. **Uptake and Translocation:** Absorbed by foliage and green bark; little or no translocation. **Basis of Selectivity:** All green plant tissue is sensitive. Less effective on plants with a very waxy cuticle and linear leaf shape such as nut sedge. Safe on mature (non-green) bark of woody plants. **Application Methods:** Postemergence. Broadcast, or directed spray to avoid contacting leaves or bark of desirable plants. Apply when weeds are less than 15 cm high. Better results are usually obtained if application is made on a dull or cloudy day, or in the evening. **Residual Activity:**

Essentially no residual activity in soil. Will persist in organic material such as mulches or turf thatch; therefore, do not reseed these areas for 5 days. More than one application per season may be necessary, especially for perennial weeds. **Unique Characteristics:** Inactivated by adsorption to soil particles. Not available to homeowners. For a domestic registration, see paraquat/diquat.

## PROPYZAMIDE

**Trade Name:** KERB. **Chemical Family:** Amide. **Crop and/or Non-Crop Registrations:** Alfalfa, bird's-foot trefoil, woody nursery stock, lettuce, apples, pears, lowbush blueberries. **Sensitive Weeds:** Perennial grasses including quack grass, annual grasses, volunteer cereals and common chickweed. **Uptake and Translocation:** Taken up by plant roots and translocated to the foliage. Little foliar absorption. **Basis of Selectivity:** Faster degradation in tolerant species. **Application Methods:** Preemergence to annual weeds. Postemergence control of perennial grasses when applied in the fall. Apply in the fall from late September to early November when the soil temperature is low but above freezing, and soil moisture is high. **Residual Activity:** Persistence is variable (2–9 months), depending on soil type and climatic conditions. Decomposition of the herbicide is slow at temperatures below 15°C but accelerates at temperatures above this level. Persistence is greatest in sandy soils with low organic matter. **Unique Characteristics:** Rainfall or irrigation is required after application to move the herbicide into the root zone for uptake by perennial grasses and germinating annual grasses.

## S-METOLACHLOR

**Trade Names:** DUAL MAGNUM, DUAL II MAGNUM. **Chemical Family:** Acetanilide. **Crop and/or Non-Crop Registrations:** Corn, soybeans, snap beans (yellow and green only), dry beans (white, kidney and pinto only), lima beans, transplanted cole crops (cabbage, cauliflower, broccoli), transplanted tomatoes, potatoes, sugar beets, processing peas, rutabagas and sweet white lupins, apples, apricots, cherries, peaches, pears and plums. **Sensitive Weeds:** Large and smooth crab grass; witch grass; barnyard grass; fall panicum; giant, green and yellow foxtail; yellow nut sedge; American nightshade, eastern black nightshade. **Uptake and Translocation:** Absorbed by germinating grasses mainly through shoot just above seed. Absorbed by germinating broadleaf weeds through roots and shoots. **Basis of Selectivity:** Metabolized by tolerant species. **Application Methods:** Early preplant, preplant incorporated and preemergence. Early postemergence on corn (spike to 2-leaf stage of corn). Incorporation equipment should be set to work the soil 10 cm deep with a disc operating at 6–10 km/hr or a vibrating shank cultivator at 10–13 km/hr; one incorpora-

tion is sufficient and need not be immediate. Rainfall within 10 days is required for maximum activity of the preemergence application. **Residual Activity:** Activity will normally be maintained for 10–14 weeks. **Unique Characteristics:** The rate required depends on weed pressure (higher rate for heavier weed pressure). Yellow nut sedge control requires a preplant incorporated application. Winter cereals may be planted 4–5 months after metolachlor application. Many tank mix combinations are registered on various crops. Do not use on muck soils or coarse-textured soils low in organic matter. DUAL II MAGNUM contains benoxacor, a chemical that enhances the corn plant's ability to metabolize s-metolachlor, thereby preventing corn injury even under adverse environmental conditions.

## SETHOXYDIM

**Trade Name:** POAST ULTRA. **Chemical Family:** Cyclohexanedione. **Crop and/or Non-Crop Registrations:** Canola (rapeseed), flax, soybeans, dry beans, snap beans, peas, onions, tomatoes, potatoes, sweet potato, pumpkin, squash, cucumbers, alfalfa, lima beans, faba beans, adzuki beans, mung beans, buckwheat, creeping red fescue, garlic, broccoli, cabbage, cauliflower, peppermint, spearmint, apples, apricots, cherries, peaches, pears, plums, highbush blueberries, cranberries and sethoxydim-resistant corn. **Sensitive Weeds:** Annual grasses (wild oats, foxtails, barnyard grass, large crab grass, proso millet, fall panicum and witch grass), volunteer corn and cereals and quack grass. **Uptake and Translocation:** Absorbed by foliage. Translocated upwards and downwards in plant. **Basis of Selectivity:** Degraded by tolerant species (broadleaf plants). **Application Methods:** Postemergence to actively growing annual grasses in the 1- to 6-leaf stage and quack grass in the 1- to 3-leaf stage. Use flat fan nozzles and add MERGE adjuvant to the spray mix. Alternatively, ASSIST OIL CONCENTRATE or Ammonium sulphate plus ASSIST OIL CONCENTRATE may be used. Other postemergence herbicides that are not recommended as tank mix combinations on the label must be applied at least 4 days before or after sethoxydim application. Aerial application is also registered. **Residual Activity:** Essentially none. A second application and/or cultivation may be necessary to control grasses that emerge after treatment. **Unique Characteristics:** Susceptible grasses, when sprayed, stop growing immediately and then gradually turn yellow to purple to brown over a period of 7–21 days, depending on growing conditions and crop competition. Rainfall within 1 hr after application may reduce effectiveness. If treated grasses are stressed (drought, flooding, prolonged cool temperatures) control will be delayed or reduced.



## SIMAZINE

**Trade Names:** PRINCEP NINE-T, SIMADEx, SIMAZINE, SIMAZINE 480. **Chemical Family:** S-triazine. **Crop and/or Non-Crop Registrations:** Corn, established asparagus, bird's-foot trefoil, raspberries, loganberries, blackberries, highbush blueberries, alfalfa, apples, apricots, cherries, peaches, pears and plums established for 1 yr or more; grapes established for 3 or more years; shelterbelts established for at least one growing season (caragana, green ash, Siberian elm, American elm and Manitoba maple); new or established Christmas tree and woodland plantations (2 yr or older white pine and balsam fir); woody ornamentals and nursery stock established for at least 1 yr (cedar, barberry, apple, flowering crab apple, box wood, cotoneaster, dogwood, holly, rose, yews, chamaecyparis, hemlock, juniper, multiflora rose, peony; spruce, mugho pine, black walnut and white ash); nursery container stock (cedar, juniper, yew); aquatic weed control; non-crop land. Conifer site preparation before planting of fir, pine and spruce (Princep Nine-T only).

**Sensitive Weeds:** Annual broadleaf weeds such as pigweed, lady's-thumb, lamb's-quarters, purslane, ragweed, volunteer clover, wild buckwheat, smartweed, plantain and groundsel; annual grasses such as barnyard grass, crab grass, wild oats and yellow foxtail (triazine-resistant biotypes of foxtail, lamb's-quarters, pigweed and groundsel will not be controlled); most perennial species starting freshly from seed. **Uptake and Translocation:** Absorbed by roots; little or no foliar absorption; translocated upwards in xylem, accumulating in apical meristem and leaves with napropamide on new plantings of apples, apricot, cherries, plums, peaches and pears. **Basis of Selectivity:** Some species, such as corn, metabolize simazine. In most crops, selectivity is based on the roots of the crop plants being deeper than the depth to which simazine leaches. **Application Methods:** Preplant incorporated (to a depth of 2.5 cm) or preemergence in corn; preemergence in other crops. Broadcast or band application. In fruit crops, apply a 1 m wide band under the plants; cultivate or sod the area between the rows. For aquatic weed control, apply as a draw-down treatment or water-volume application in drainage ditches and ponds with no water flow-through. **Residual Activity:** Soil residues may persist for more than 1 season. After spraying with simazine, do not plant any crop in the treated area in the same year except corn. Where rates in excess of 2 kg/ha have been applied, do not plant rotational crops in the following year; soils should be tested if there is any question of excessive residues remaining. **Unique Characteristics:** Needs sufficient moisture to be activated. Should be applied only once per season. To avoid build-up of resistant weeds, simazine should be rotated with other non-triazine residual herbicides. Simazine is more persistent than atrazine. Where

rainfall is sufficient to cause erosion, soil containing simazine may wash to lower areas of land and injure existing or subsequent crops.

## SURFACTANTS

(See AGRAL 90, AG-SURF, COMPANION, CANPLUS 411, CITOWETT PLUS, ENHANCE, LI700, MERGE, SIDEKICK, SYLGARD 309).

## TERBACIL

**Trade Name:** SINBAR. **Chemical Family:** Uracil. **Crop and/or Non-Crop Registrations:** apples, apricots, cherries, highbush blueberries, peaches, pears, plums, spearmint, peppermint, and strawberries; with napropamide on new plantings of apples, apricots, cherries, plums, peaches and pears. **Sensitive Weeds:** Barnyard grass, bluegrass, crab grass, foxtail, chickweed, cheat grass, perennial ryegrass, wild barley, mustard, prickly lettuce, stinkweed, annual sow-thistle, henbit, lamb's-quarters, pigweed, purslane and ragweed. Partial control of quack grass, horsenettle, vetch and yellow nut sedge. **Uptake and Translocation:** Uptake is mostly through roots, although partially through foliage and stem. Translocation is upward into leaves. **Basis of Selectivity:** Used only on established plantings so that roots of crop are below depth to which chemical penetrates. May also be slower translocation and faster degradation in tolerant species. **Application Methods:** Apply to the soil surface in 200–1000 L water/ha. If weed growth is present in apples, paraquat may be mixed with spray. Rates for strawberries are considerably lower and can be applied in spring, post-harvest or late fall. Control of perennial grasses may be improved by cultivation prior to treatment. **Residual Activity:** May be up to 2 yrs. Residues are likely to be higher on heavier soil types if higher rates and repeated applications are used. **Unique Characteristics:** Moisture is necessary to activate the chemical within 2 weeks after application. Do not apply on soils with less than 1% organic matter, nor on eroded soil areas. Use lower rates on soils with 1%–2% organic matter. Do not apply on weak or diseased strawberry plants.

## TRIFLURALIN

**Trade Names:** BONANZA 400, RIVAL, TREFLAN. **Chemical Family:** Dinitroaniline. **Crop and/or Non-Crop Registrations:** Soybeans, dry beans (white or kidney), faba beans, snap beans, lima beans, black beans, canola (rapeseed), triazine-tolerant canola (variety of O.A.C. Triton, pedigreed seed only), sunflowers, turnips, peas (field and canning), direct-seeded alfalfa; transplants of tomatoes, peppers, Brussels sprouts, broccoli, cabbage and cauliflower; carrots, crambe, direct-seeded cabbage and cauliflower, annual flowers, woody ornamental plant-

ings and field-grown nursery stock, perennials, established shelterbelts, **strawberries**. **Year of planting fruit trees.** **Sensitive Weeds:** Effective on most annual grasses, and will provide good control of pigweed and lamb's-quarters, including the triazine-tolerant biotypes of these weeds.

**Uptake and Translocation:** No significant absorption or translocation of trifluralin in crops grown in soil treated with trifluralin. Susceptible weeds are controlled as they germinate. Established weeds are not controlled. **Basis of Selectivity:** Physiological growth processes associated with seed germination. **Application Methods:** Preplant incorporated. Apply in 100–300 L of water/ha. Use lower rate of the chemical on sandy soils and increased rate for loam-to-clay soils. Do not use on highly organic soils (muck, peat or black sands above 15% organic matter). Incorporate twice in cross directions using a tandem disc (7–10 km/hr) or tine cultivator (10–13 km/hr) set to work

8–10 cm deep. The first incorporation should be done as soon as possible after application, but may be delayed 8–24 hrs, depending on label directions. The second incorporation is recommended anytime before planting. Activated upon incorporation; rainfall is not required. **Residual Activity:** Recommended application rates provide season-long weed control. Succeeding crops, even fall-seeded grain crops planted in soil that received trifluralin the preceding spring, will not be injured under normal conditions.

**Unique Characteristics:** Strongly adsorbed to soil particles and shows negligible leaching. Organic matter and clay content influence application rate. Does not control ragweed, annual nightshades or mustards; lady's-thumb may escape.

## WATER-SOLUBLE DYES

See AQUASHADE

Visit the weed control page on the OMAFRA web site at  
<http://www.gov.on.ca/OMAFRA/english/crops/insects/weeds.html>

TABLE 12–1. Herbicide Groupings for Ontario

Group <sup>1</sup>	Site of Action	Single modes of action (alphabetic order)	Two or more modes of action (alphabetic order) <sup>2</sup>
1	Inhibitors of acetyl CoA carboxylase (ACCase)	Acclaim Super, Achieve, Assure, Assure II, Excel Super, Fusilade II, Hoe-grass 284, Poast Ultra, Select, Venture 25G	
2	Inhibitors of acetolactate synthase (ALS) and also called acetohydroxyacid synthase (AHAS)	Accent, Arsenal, Classic, Elim EP, Muster, Pinnacle, Peak, Prism, Pursuit, Refine Extra, Reliance STS, Telar, Ultim, Viper	Broadstake Dual(2,15), Broadstake Treflan(2,3), Conquest <sup>3</sup> (2,5), Fieldstar(2,4), Patriot(2,5), PeakPlus <sup>3</sup> (2,4), Striker(2,4), Ultimax <sup>3</sup> (2,4), Valor(2,3), Viper <sup>3</sup> (2,14)
3	Microtubule assembly inhibitors	Edge, Bonanza 400, Dimension, Prowl, Rival, Treflan	Broadstrike Treflan(2,3), Valor(2,3)
4	Synthetic auxins	Banvel II, Caliber 400, Cobutox 600, Compitox, Covitox Plus, Dichlorprop-D, Diphenoprop, Dycleer, Dyvel, Embutox 625, Estaprop, Estasol, Estamine 2,4-D, Ester, Expedite Broadleaf, Garlon 4, Kil-Mor, Killex, Lontrel, MCPA, Mecoprop, Mecocrop 2,4-D, Mecoturf Plus 2,4-D, Meco-D, Par III, Premium 3-Way, Release, See 2,4-DB, Target, Tordon 101 mix, Tricep, Tu.1 Herbicide, Turf-Rite 2+2, Turboprop, Weedone CB	Buctril M(4,6), Calmix Pellets(4,5), Distinct(2,19), Fieldstar(2,4), Marksman(4,5), PeakPlus <sup>3</sup> (2,4), Shotgun(4,5), Stampede CM(4,7), Striker(2,4), Ultimax <sup>3</sup> (2,4),
5	Inhibitors of photosynthesis at photosystem II, Site A	Aatrex, Atrazine, Bladex, Gesagard, Hyvar X, Lexone, Princep Nine-T, Pronone, Pyramin FL, Sencor, Simadex, Simazine, Sinbar, Velpar	Calmix Pellets(4,5), Conquest <sup>3</sup> (2,5), Krovar(5,7), Laddok(5,6), Marksman(4,5), Patriot(2,5), Primextra II Magnum(5,15), Primextra Light(5,15), Shotgun(4,5),
6	Inhibitors of photosynthesis at photosystem II, Site A	Basagran, Basagran Forte, Lentagran, Pardner	Buctril M(4,6), Laddok(5,6)
7	Inhibitors of photosynthesis at photosystem II, Site B	Afesin, Afolan F, Betamix, Betanex, Herbec 20P, Karmex, Linuron 480, Lorox, Patoran FL, Spin-Aid	Krovar(5,7), Stampede CM(4,7)

TABLE 12-1. Herbicide Groupings for Ontario (cont'd)

Group <sup>1</sup>	Site of Action	Single modes of action (alphabetic order)	Two or more modes of action (alphabetic order) <sup>2</sup>
8	Conjugation of acetyl co-enzyme A	Avadex BW, Avenue 200C, Betasan, Eradicane, Eptam, Ro-Neet	
9	Inhibitors of 5-enolpyruvylshikimate-3-phosphate synthase (EPSP)	Clear-It, Credit, Expedite Grass & Weed, EZJect, Glyfos, Laredo, Renegade, Roundup, Touchdown 480, Vantage, Vision, Wrangler	Roundup Fast Forward(9,10)
10	Inhibitors of glutamine synthetase	Liberty 200 SN, Ignite	Roundup Fast Forward(9,10)
11	Inhibitors of carotenoid biosynthesis	Amitrol 240, Amitrol-T	
14	Inhibitors of protoporphyrinogen oxidase (Protox)	Blazer, Goal 2XL, Reflex, Ronstar 2G	Viper <sup>3</sup> (2,14)
15	Conjugation of acetyl co-enzyme A	Devrinol, Dual, Dual Magnum, Dual II Magnum, Frontier	Broadstrike Dual(2,15), Primextra II Magnum(5,15), Primextra Light(5,15)
19	Inhibitors of auxin transport system	Alanap	Distinct(2,19)
20	Inhibits cell wall synthesis, Site A	Casoron 4G	
22	Photo system I - electron diverters	Gramoxone, Reglone, Reglone A, Weed & Grass Killer	
23	Inhibitors of mitosis	CIPC	
27	others	Basamid, Krenite, Vapam	

<sup>1</sup> Herbicide groupings for Ontario follow the Weed Science Society of America's nationally accepted grouping. Since groups 12, 13, 16, 17, 18, 21, 24, 25 and 26 are not available in Ontario, they have been removed to simplify the chart.

<sup>2</sup> Products with two or more sites of action are followed by the group numbers involved.

<sup>3</sup> Indicates herbicides sold as a co-pack under this trade name

TABLE 12-2. Interval Before Rainfall (Post-Emergent Herbicides)

Rainfall shortly after application of a post-emergent herbicide may reduce the weed control. This effect will vary with the product, the formulation, the interval of time and the drying conditions between application and rainfall, as well as on the amount, intensity, and duration of rainfall. The following information is based on label information and additional detail supplied by the chemical industry. **For further information, contact the manufacturer.** In the case of a tankmix, use the longest time interval of the products being considered.

0 to 15 Minutes	1 Hour	2 Hours	4 Hours	6 Hours	8 Hours
GRAMOXONE	POAST ULTRA	FUSILADE II	2,4-D AMINE	AMITROL 240	AFOLAN F
			IGNITE	BASAGRAN	LINURON 480
			LONTREL	GLYFOS	LOROX
			ROUNDUP	LEXONE	
			TRANSORB		
			TROPOTOX PLUS	ROUNDUP	
				SENCOR	
				TOUCHDOWN	

**TABLE 12-3. Non-Selective Herbicides Available for Preplant Site Preparation**

CROP	GLYFOS, ROUNDUP TRANSORB, TOUCHDOWN 480	VAPAM	VORLEX PLUS/ PLUS CP
<b>Fruit Crops</b>			
fruit	X	X	
small fruits i.e. strawberries	X		X

**TABLE 12-4. Preplant Herbicide Weed Control Ratings**

Weed control ratings are given as 0-9 where 0 indicates no control and 9 indicates 90%-100% control under ideal conditions. Ratings are subjective values based on best available information and give general comparisons based on use as described in this guide. Under unfavorable conditions (eg., too dry, too wet, too cold, or poor application) the herbicides may not be as effective as indicated. Ratings may vary with weed and crop stage and with the timing and rates of the product(s) being used. Ratings in **BOLD** suggest the weed is listed on the product label for control or suppression. Please see product label for more information on registered weed species, product uses and precautions.

		Perennials																	
Treatment	Trade Name	annual grasses	annual broadleaves	bindweed, field	chickweed, mouse-eared	dandelion	golden-rod	ground-ivy (creeping Charlie)	horsetail	mallow	milkweed	nut sedge	plantains	poison ivy	quackgrass	sow-thistle	thistle, Canada	vetches	
amitrole	AMITROL 240	**	**	a	?	9	a	?	7	?	a	a	8	8	7	a	7	?	
glyphosate	GLYPHOS, ROUNDUP, TOUCHDOWN	**	**	7 <sup>a</sup>	9	7/8 <sup>d</sup>	?	5	0	5	a	7	9	8	8/9	a	7 <sup>a</sup>	5	
glufosinate ammonium	IGNITE	**	**	8 <sup>c</sup>	?	8	?	?	7 <sup>c</sup>	?	6 <sup>c</sup>	7 <sup>c</sup>	?	?	8 <sup>c</sup>	8 <sup>c</sup>	8 <sup>c</sup>	?	
paraquat	GRAMOXONE	**	**	b	b	b	?	b	b	b	b	0	b	b	5	b	0	b	

\*\* Indicates that most annual weeds will be controlled if emerged.

? Insufficient information available to make a rating.

<sup>a</sup> Optimum growth stages for best control of these weeds will not likely be attained prior to planting in early to mid spring.

<sup>b</sup> Top growth only, regrowth can be expected.

<sup>c</sup> Repeated applications may be necessary.

<sup>d</sup> Use higher rates for plants over 15 cm tall or across.



## Special Methods Of Weed Control - Preplant-Site Preparation

amitrole AMITROL 240 (231 g/L)	1 to 2 kg/ha 4.2 to 8.4 L/ha	1.68 to 3.36 L/ac	Apply in 100-200 L/ha water (40-180 L/ac) 10-14 days before planting the crop. Soybeans may be planted 6 days after application when applied at the low rate. Use additional herbicide treatments to control weed species that emerge after amitrole application. Amitrole will not provide residual weed control.
amitrole AMITROL 240 (231 g/L)	3 to 4 kg/ha 12.5 to 16.5 L/ha	5 to 6.6 L/ac	ONLY FOR USE BEFORE WHITE BEANS, CORN AND SOYBEANS. Apply to actively weeds up to 10 cm tall and Canada thistle in the fall or spring. Plow or thoroughly disk 10-14 days after application. Cultivation may be required when the crop is emerged.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	0.27 to 1.26 kg/ha 0.75 to 3.5 L/ha 0.75 to 3.5 L/ha 0.249 to 1.155 kg/ha 0.75 to 3.5 L/ha	0.3 to 1.4 L/ac 0.3 to 1.4 L/ac 0.3 to 1.4 L/ac	See the product labels for specific details. Glyphosate can be applied to actively growing weeds in the fall, or spring prior to emergence of any crop. Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. Refer to the product label for specific rates for annual weeds. The low rate must be applied 50 to 100 L/ha water (20-40 L/ac). Apply the low rate plus a surfactant if greater volumes of water are used. Higher rates may be applied in 100 to 300 L/ha water (40-120 L/ac).
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	0.9 to 2.52 kg/ha 2.5 to 7 L/ha 2.5 to 7 L/ha 0.825 to 2.31 kg/ha 2.5 to 7 L/ha	1 to 2.8 L/ac 1 to 2.8 L/ac 1 to 2.8 L/ac	For perennial grass control apply to actively growing plants with at least 3-4 new leaves. The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of one season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	2.52 to 4.32 kg/ha 7 to 12 L/ha 7 to 12 L/ha 2.31 to 3.96 kg/ha 7 to 12 L/ha	2.8 to 4.8 L/ac 2.8 to 4.8 L/ac 2.8 to 4.8 L/ac	Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. All species should be actively growing at application time. Allow 5 to 7 days translocation time after application before doing any tillage when conditions are good. If cool temperatures follow application, allow additional time for translocation to be completed before disturbing treated weeds. Use the higher rate for best control of solid stands of undisturbed perennials such as sod in non-crop areas. Repeat application to regrowth may be necessary for complete control.
glyphosate/glufosinate ammonium ROUNDUP FASTFORWARD PRESEED ((30:1) 310g/L)	0.465 to 1.302 kg/ha 1.5 to 4.2 L/ha	0.6 to 1.7 L/ac	0.6 L/ac is recommended mainly for annual grass weeds up to 15 cm in height. 1.1 L/ac is recommended for annual grass and broadleaf weeds up to 15 cm in height. 1.7 L/ac is recommended for annual weeds over 15 cm in height. See label for more details.
glyphosate/glufosinate ammonium ROUNDUP FASTFORWARD PRESEED ((30:1) 310g/L)	0.93 to 2.604 kg/ha 3.0 to 8.4 L/ha	1.2 to 3.4 L/ac	Use the higher rates for heavier infestations and for dandelions larger than 15 cm. 1.5 L/ac and 2 L/ac are recommended for average quackgrass and dandelion infestations respectively.
paraquat GRAMOXONE (200g/L)	0.55 to 1.1 kg/ha 2.75 to 5.5 L/ha	1.1 to 2.2 L/ac	Apply paraquat to actively growing vegetation at least 3 days prior to crop emergence. Use the high rate when weeds are above 5 cm in height. Apply paraquat in 300 to 1100 L/ha water (120-440 L/ac). Complete coverage is important. Use higher water volumes on dense vegetation. Perennial weeds will only be suppressed. Only emerged weeds will be controlled.



Apply in a minimum of 110-330 L/ha (44-132 L/ac) of water in carrot, lettuce and onion crops only. IGNITE may be applied as a stale seedbed technique prior to emergence of the crop. See label for more detailed information.

Till and fertilize soil in early spring. Allow weeds to grow. Spray weeds just before seeding crop. Use low rate for small weeds (8 cm), medium rates for weeds 8 to 15 cm and higher rate for weeds over 15 cm tall. Apply recommended preemergence or postemergence herbicides to control new flushes of weeds or use mechanical means of control.

0.6 L/ac is recommended mainly for annual grass weeds up to 15 cm in height. 1.1 L/ac is recommended for annual grass and broadleaf weeds up to 15 cm in height. 1.7 L/ac is recommended for annual weeds over 15 cm in height. See label for more details.

Use the higher rates for heavier infestations and for dandelions larger than 15 cm. 1.5 L/ac and 2 L/ac are recommended for average quackgrass and dandelion infestations respectively.

One of these herbicides may be used to kill emerged weeds on a prepared seedbed before the crop seed is sown. Check label for list of crops for which this technique is registered. In inter-row weeding, special low pressure equipment is used to apply the herbicide on emerged weeds without contact with leaves of the crop plants. For small areas, apply 30 mL product in 10 L water per 100 m<sup>2</sup>.

DOMESTIC - Soluble granular formulations for home garden use. Check label for rates.

## Spot Treatment

### Spot Treatment with Hand-Held Equipment For Selective Weed Control

REGISTERED FOR NON-CROP LAND AND PASTURE. Thoroughly wet all leaves and stems of weeds. Refer to label for appropriate stage of weed growth. Repeat applications when new growth appears. DO NOT let livestock eat treated vegetation. Keep livestock off treated area until weeds are dead and new growth has emerged.

EXPEDITE herbicides are ready-to-use products which must be applied with the EXPEDITE application system. This low volume application should not be applied "spray to wet" or runoff. Material should be calibrated for proper use rate prior to application. Consult label for calibration and application instructions.

EXPEDITE herbicides are ready-to-use products which must be applied with the EXPEDITE application system. This low volume application should not be applied "spray to wet" or runoff. Material should be calibrated for proper use rate prior to application. Consult label for calibration and application instructions.

glyphosate ammonium  
IGNITE (150g/L)

0.405 to 0.75 kg/ha  
2.7 to 5 L/ha

1.08 to 2 L/ac

glyphosate  
ROUNDUP TRANSORB  
(360g/L)

0.27 to 1.26 kg/ha  
0.75 to 3.5 L/ha

0.3 to 1.4 L/ac

plus surfactant

AGRAL 90, AGSURF,  
ENHANCE

0.35 L/ha

0.14 L/ac

glyphosate/glyphosate ammonium  
ROUNDUP FASTFORWARD  
PRESEED (30:1) 310g/L)

0.465 to 1.302 kg/ha  
1.5 to 4.2 L/ha

0.6 to 1.7 L/ac

glyphosate/glyphosate ammonium  
ROUNDUP FASTFORWARD  
PRESEED (30:1) 310g/L)

0.93 to 2.604 kg/ha  
3.0 to 8.4 L/ha

1.2 to 3.4 L/ac

paraquat

GRAMOXONE (200g/L)

or diquat

REGLONE (200g/L)

0.6 to 1.1 kg/ha  
3 to 5.5 L/ha  
0.6 to 1.1 kg/ha  
3 to 5.5 L/ha

1.2 to 2.2 L/ac  
1.2 to 2.2 L/ac

paraquat/ diquat

C.I.L. WEED & GRASS KILLER  
WEED-BAN

See Label

DOMESTIC - Soluble granular formulations for home garden use. Check label for rates.

amitrole  
AMITROL 240 (231g/L)

3 to 4 kg/ha  
12.5 to 16.5 L/ha

5 to 6.6 L/ac

glyphosate  
EXPEDITE GRASS & WEED  
(147g/L)

0.88 to 1.25 kg/ha  
6 to 8.5 L/ha

2.4 to 3.4 L/ac

glyphosate  
EXPEDITE GRASS & WEED  
(147g/L)

1.25 to 2.5 kg/ha  
8.5 to 17 L/ha

3.4 to 6.8 L/ac

6.8 to 11.6 L/ac

EXPEDITE herbicides are ready-to-use products which must be applied with the EXPEDITE application system. This low volume application should not be applied "spray to wet" or runoff. Material should be calibrated for proper use rate prior to application. Consult label for calibration and application instructions.

See label for appropriate stage of weed development and for a list of crops for which this technique is registered.

See label for appropriate stage of weed development and for a list of crops for which this technique is registered.

Apply to weeds which extend above the crop sufficiently to allow good contact with the application equipment. Be careful not to contact the crop with the equipment to allow the chemical solution to drip from the applicator on to the crop. A 33% herbicide mixture (1 L to 2 L of water) provides good control of most weeds.

glyphosate  
EXPEDITE GRASS & WEED  
(147g/L)

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)  
or glyphosate TMS  
TOUCHDOWN 480 (330g/L)

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)  
or glyphosate TMS  
TOUCHDOWN 480 (330g/L)

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)  
or glyphosate TMS  
TOUCHDOWN 480 (330g/L)

## Horticultural Crops

Vegetable, fruit and ornamental crops number in excess of more than 50 crops. Some are seeded, some transplanted, some are annuals, other crops are perennial, presenting a very diverse group of situations to manage weeds.

Perennial weeds are often a more severe problem in perennial horticultural crops such as asparagus, berry crops, fruit crops and ornamentals (perennials). Quackgrass, bindweed, thistles, horsetail, dandelions, etc. should be controlled before these crops are planted.

Recommendations for some horticultural crops such as snap beans or sweet corn will be found in the field crop section because they are similar to those for field corn and field beans. Differences are noted where necessary.

Treatments listed for horticultural crops in the publication are based on extensive research trials. Herbicides should not be used in cold frames or greenhouses unless specifically recommended.

Weed management involves all aspects of weed control in horticultural crops including herbicides, cultivation, hoeing, mulches, weed prevention, etc.

Horticultural crops are often high value crops. Weed competition is costly. Improper application of herbicides also can be costly. Sprayers used for hormone type herbicides (2,4-D, etc.) should not be used to apply insecticides, fungicides or other herbicides on susceptible horticultural crops.

### WEED CONTROL IN GARDENS

Many garden plants can be killed or damaged by the chemicals used to kill weeds. The frequent use of a hoe, or other shallow cultivation, is the most practical method of controlling weeds in gardens. Most annual weeds can be killed with one or two cultivations. Perennial weeds can be controlled by any kind of cultivation which removes all top growth at frequent intervals. After the food stored in the roots has been used, the weeds will die.

When it is possible to apply the chemical to one kind of garden plant, without danger of spray or dust drifting onto susceptible garden plants, one of the chemicals recommended in this publication may be used. (Check list below.) Granular formulations can be applied using a jam jar with a perforated top. This "salt shaker" method, after a little practice, is effective and quick. A small compressed air sprayer can be used to apply any liquid or wettable powder which is mixed with water. It is important that the correct amount be applied. One way of ensuring accuracy is to fill the garden sprayer with water to a mark - apply the spray to 100 m<sup>2</sup> taking care to apply it as evenly as possible, and then measure the amount of water used. Add the chemical recommended in the publication to this amount of water for each 100 m<sup>2</sup> treated.

As a guide in converting the recommended rate of any chemical to the amount required for a small area, 32 g per 100 m<sup>2</sup> is approximately equal to 3.25 kg/ha. For liquid measure, 2 level lbs is approximately 28 mL. One L of spray mixture per 100 m<sup>2</sup> is equal to 100 L/ha.

The herbicides listed under each crop are available for farm, custom spraying, and industrial use. The Ontario Pesticides Act restricts the sale of herbicides to the home gardener to those with a domestic label.

## Cultural-Weed Control in Fruit and Ornamental Crops

A successful weed control program must integrate cultural and chemical weed control practices. Growers cannot depend entirely on chemical weed control in fruit crops, since there is a limited spectrum of herbicides registered for these crops.

### PERENNIAL WEED CONTROL

It is important to identify and control perennial weeds in the preplanting year. It is very difficult to control perennial weeds once a planting is established because of crop sensitivity to some herbicides and since it is not possible to clean cultivate in established orchards, vineyards, berry crops and nurseries.

The following perennial weeds present serious problems in these crops: quackgrass, bindweed, vetch, wild grape, perennial nightshade, thistles, ground-ivy (creeping charlie) and burdock. In strawberries, sheep sorrel, toadflax and milkweed also present problems.

Appropriate herbicides such as glyphosate (ROUNDUP) or amitrole (AMITROL 240) should be applied to perennial weeds in the preplanting year. Consult the product label and be sure to use the recommended rate for the weed in question. Apply the herbicide at the proper stage of growth of the weed, otherwise only temporary control will be achieved. Repeated cultivations of some perennial weeds such as bindweed will also provide control.

### SITE PREPARATION

A green manure crop such as perennial rye-grass or sudan grass should be established in the preplanting year following or in conjunction with measures to control perennial weeds. This crop will provide competition to reduce weed growth as well as improving the soil structure. Non selective herbicides can be applied before planting the green manure crop and before plowing it under. Short residual selective herbicides such as 2,4-D may be used with the green manure crop, but avoid using herbicides that leave a soil residue that will carry over into the planting year.

### MULCHING

A biodegradable plastic mulch could be used for weed control in the planting strip. A straw mulch will also assist in weed control beneath the trees or in the planting strip if it is applied early in the season before the weed seeds germinate. Use mulch that is free of weed seeds and ensure that enough nitrogen is provided for the plants. The mulch should be pulled away from around the tree bases for winter rodent protection. Peastone gravel is another option that can be applied around the base of the trees. It will provide weed control as well as improving drainage, encouraging deeper rooting and discouraging rodents.

### REDUCING WEED PRESSURE

Cultivation can provide weed control between the rows. Alternatively, a vigorous sod between the rows will prevent weeds from becoming established. It is better to seed in a fescue sod than to rely on a natural sod composed of weed and grass species, since the weeds will seed into the herbicide strip.

Prevent weeds from setting seed in adjacent uncropped areas by using cultural or chemical weed control measures. Mowing at regular intervals will prevent many weeds from flowering. Try to control weeds which escape before they set seed, by cultural removal or chemical mowing. In some situations, tools such as a weed whip may be of use. Mowers are available which will cut close to the trees without injury. Mowing, however, will not eliminate weed competition.

### ROTATING HERBICIDE FAMILIES (SEE HERBICIDE GROUPINGS FOR ONTARIO TABLE)

In perennial crops, rotation of herbicide families is important to minimize the building up of seed from weed escapes, including triflazine tolerant weeds. Rotation will also help avoid an accumulation of herbicide residues in the soil that may result in crop injury over a period of years and may hinder replanting.

## Apples

**Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60-120 L/ac) water.**

**PREPLANT** - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

**PREPLANT INCORPORATED** - Two incorporations at right angles operating at a depth of 10 cm using a double disk (7-10 km/hour) or vibrating shank S-tine cultivator (10-13 km/hour) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

**PREEMERGENCE** - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of orchard.

**dichlobenil**  
**CASORON 4G (4 Gr)**  
4.4 to 7 kg/ha  
110 to 175 kg/ha  
44 to 70 kg/ac  
Apply before weeds emerge or after cultivation. 70 g of CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT apply until 4 weeks after transplanting. DO NOT use on light sandy soils.

**metribuzin**  
**LEXONE DF (75 DF)**  
0.38 to 0.75 kg/ha  
0.5 to 1 kg/ha  
0.2 to 0.4 kg/ac  
Apply as a preplant incorporated treatment in the year of planting. Make a single application as an orchard floor or planting row treatment. Consult label for incorporation instructions.

**metribuzin**  
**SENCOR 75 DF (75 WG)**  
0.42 to 0.56 kg/ha  
0.55 to 0.75 kg/ha  
0.6 to 1.155 kg/ha  
plus trifluralin  
**TREFLAN (480g/L)**  
1.25 to 2.4 L/ha  
**BONANZA 400 (400g/L)**  
1.5 to 2.75 L/ha  
0.22 to 0.3 kg/ac  
0.5 to 0.96 L/ac  
0.6 to 1.1 L/ac  
Apply and incorporate before planting trees. Apply only once in the year of planting, as an orchard floor or planting row treatment.

**napropamide**  
**DEVINOL DF (50 DF)**  
4.5 kg/ha  
9 kg/ha  
3.6 kg/ac  
Apply after planting trees, but before weeds emerge. Use a directed spray at low pressure. Incorporation by rainfall or irrigation is essential within 2 days of application.

**napropamide**  
**DEVINOL DF (50 DF)**  
3.5 kg/ha  
7 kg/ha  
2.025 kg/ha  
plus simazine  
**PRINCEP NINE-T (90WG)**  
2.25 kg/ha  
Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make only one application in the planting year.

**napropamide**  
**DEVINOL DF (50 DF)**  
4.5 kg/ha  
9 kg/ha  
0.5 kg/ha  
plus terbacil  
**SINBAR (80 WP)**  
0.63 kg/ha  
3.6 kg/ac  
0.25 kg/ac  
Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground or during harvest. Make one application in the planting year only.

**s-metolachlor**  
**DUAL MAGNUM (915g/L)**  
1.14 to 1.6 kg/ha  
1.25 to 1.75 L/ha  
0.99 to 1.98 kg/ha  
plus simazine  
**PRINCEP NINE-T (90WG)**  
1.1 to 2.2 kg/ha  
**SIMAZINE 80W (80WP)**  
1.25 to 2.5 kg/ha  
0.5 to 0.7 L/ac  
0.44 to 0.88 kg/ac  
0.5 to 1 kg/ac  
Apply once in the year of planting only. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, pre-emergent to weeds, preferably after rain has settled the soil around the trees. Avoid contact with tree trunks and leaves.



simazine	1 to 2 kg/ha	Apply once per season. Avoid contact with trunk and leaves of trees. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees.
PRINCEP NINE-T (90WG)	1.1 to 2.2 kg/ha	0.44 to 0.88 kg/ac
SIMAZINE 80W (80WP)	1.25 to 2.5 kg/ha	0.5 to 1 kg/ac
terbacil	1 kg/ha	Apply after planting trees, before weeds emerge. DO NOT use on soils with less than 2% organic matter. Avoid contact with tree trunks and leaves.
SINBAR (80 WP)	1.25 kg/ha	0.5 kg/ac
trifluralin	0.6 to 1.155 kg/ha	Apply and incorporate before planting trees. Use at least 100 L/ha water (40 L/ac). Apply once in the planting year only.
TREFLAN (480g/L)	1.25 to 2.4 L/ha	0.5 to 0.96 L/ac
BONANZA 400 (400g/L)	1.5 to 2.75 L/ha	0.6 to 1.1 L/ac
fluazifop-p-butyl	0.125 kg/ha	Apply to actively growing annual grasses in the 2-5 leaf stage of growth.
FUSILADE II (125g/L)	1 L/ha	0.4 L/ac
fluazifop-p-butyl	0.25 kg/ha	Treat actively growing quackgrass at the 3-5 leaf stage.
FUSILADE II (125g/L)	2 L/ha	0.8 L/ac
sethoxydim	0.15 to 0.2 kg/ha	Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.
POAST ULTRA (450g/L)	0.32 to 0.47 L/ha	0.13 to 0.19 L/ac
plus surfactant/solvent		
MERGE	2 L/ha	0.8 L/ac
sethoxydim	0.5 kg/ha	Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained 7 to 21 days after application.
POAST ULTRA (450g/L)	1.1 L/ha	0.45 L/ac
plus surfactant/solvent		
MERGE	2 L/ha	0.8 L/ac
bentazon	0.84 to 1.08 kg/ha	Direct under trees to small actively growing weeds. Avoid tree leaves. Apply in 100 to 400 L/ha water (40-160 L/ac) with at least 275 kPa pressure. Use lower rate of ASSIST under hot, humid conditions. Two applications, 10 days apart at 1.75 L/ha (0.7 L/ac) may be applied in the year of planting only.
BASAGRAN (480g/L)	1.75 to 2.25 L/ha	0.7 to 0.9 L/ac
plus oil concentrate		
ASSIST	1 to 2 L/ha	0.4 to 0.8 L/ac
clpyralid	0.202 kg/ha	Apply in the spring at early flowering stage of vetch as a spot treatment. Avoid contact with tree limbs. DO NOT apply closer than 30 days to harvest.
LONTREL 360 (360g/L)	0.56 L/ha	0.22 L/ac
propyzamide	2.25 kg/ha	Apply from late September to early November when soil is cool and moist but not frozen. Use only under apple trees established at least one year. 4.5 kg/ha is equivalent to 45 g/100 m <sup>2</sup> .
KERB (50 WP)	4.5 kg/ha	1.8 kg/ac
s-metolachlor	1.6 kg/ha	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.
DUAL MAGNUM (915g/L)	1.75 L/ha	0.7 L/ac

Active ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT PER HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information, see "Notes on Chemicals" section.)
metribuzin LEXONE DF (75 DF)	0.75 kg/ha 1 kg/ha	0.4 kg/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with tree trunks and leaves.
dichlobenil CASORON 4G (4Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	44 to 70 kg/ac	Apply in fall or early spring before weeds emerge. 70 g of CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha. DO NOT use on light sandy soils.
linuron LOROX DF (50 DF) AFOLAN F (480g/L) LINURON 480 (480g/L)	4.5 kg/ha 9 kg/ha 9.4 L/ha 9.4 L/ha	3.6 kg/ac 3.76 L/ac 3.76 L/ac	Apply as directed spray before weeds are 10 cm high in 400-600 L/ha water (160-240 L/ac). Add a surfactant. Avoid contact with fruit, foliage or tree bark with spray or drift. Use only under trees established at least 10 years.
napropamide DEVIRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit and foliage. DO NOT apply when fruit is on the ground during harvest.
s-metolachlor DUAL MAGNUM (915g/L) plus metribuzin LEXONE DF (75 DF)	1.6 kg/ha 1.75 L/ha 0.75 kg/ha 1 kg/ha	0.7 L/ac 0.4 kg/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.
s-metolachlor DUAL MAGNUM (915g/L) plus simazine PRINCEP NINE-T (90WG)	1.6 kg/ha 1.75 L/ha 2.25 kg/ha 2.5 kg/ha	0.7 L/ac 1 kg/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter. Late season crabgrass and fall panicum may escape this treatment.
simazine PRINCEP NINE-T (90WG) SIMADEX (500g/L) SIMAZINE 480 (480g/L)	2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha 4.7 to 9.4 L/ha	1 to 2 kg/ac 1.8 to 3.6 L/ac 1.88 to 3.76 L/ac	Apply in 300 to 1000 L/ha water (120-400 L/ac). Use only under trees planted for one year or more. Use higher rate on perennial weeds such as quackgrass. May be combined with glyphosate.
terbacil SINBAR (80 WP)	1.8 to 3.6 kg/ha 2.25 to 4.5 kg/ha	0.9 to 1.8 kg/ac	Apply in 1000 L/ha water (400 L/ac). Use only under trees established for at least 3 years.
terbacil SINBAR (80 WP) plus metribuzin LEXONE DF (75 DF)	0.5 kg/ha 0.63 kg/ha 0.75 kg/ha 1 kg/ha	0.25 kg/ac 0.4 kg/ac	Apply as a band under trees before weeds emerge. Use only one application per year. DO NOT USE on soil coarser than sandy loams with less than 3% organic matter.
fluzifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/ac	Apply to actively growing annual grasses in the 2-5 leaf stage of growth.
fluzifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/ac	Apply to actively growing quackgrass in the 3-5 leaf stage of growth.

sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.15 to 0.2 kg/ha 0.32 to 0.47 L/ha 2 L/ha	0.13 to 0.19 L/ac 0.8 L/ac	Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.5 kg/ha 1.1 L/ha 2 L/ha	0.45 L/ac 0.8 L/ac	Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained 7 to 21 days after application.
2,4-D 2,4-D AMINE 600 (560g/L)	0.95 kg/ha 1.7 L/ha	0.68 L/ac	To control broadleaf weeds, including dandelion, and seedling Canada thistle and sow thistle. Apply in early spring after weeds emerge (but no closer than 80 days to harvest), or postharvest to actively growing weeds. DO NOT apply when useable fruit is on the orchard floor.
clopyralid LONTREL 360 (360g/L)	0.202 kg/ha 0.56 L/ha	0.22 L/ac	Apply in the spring at early flowering of vetch as a spot treatment. Avoid contact with tree limbs. DO NOT apply closer than 30 days to harvest. For control of emerged vetch.
amitrole AMITROL 240 (231g/L)	2.25 to 3.25 kg/ha 9.4 to 13.5 L/ha	3.76 to 5.4 L/ac	Spray after weed foliage has fully developed. For grass and poison-ivy control, spray to wet all foliage, stems and suckers to the ground. Keep spray off tree trunks as much as possible. DO NOT USE WITHIN 30 DAYS BEFORE HARVEST. For all emerged weeds including poison ivy.
glufosinate ammonium IGNITE (150g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	1.08 to 2 L/ac	Apply as a directed spray before weeds are 30 cm high. Use 110-330 L/ha water (44-132 L/ac). Where weed growth is heavy, use the higher rate and larger water volume. DO NOT harvest until 40 days after application. For trees established at least one year.
glufosinate ammonium IGNITE (150g/L) plus simazine PRINCEP NINE-T (90WG) SIMADEX (500g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha	1.08 to 2 L/ac 1 to 2 kg/ac 1.8 to 3.6 L/ac	For control of emerged weeds plus residual control of annual grasses and broadleaf weeds. Use as a directed spray around the bases of trees established at least one year. DO NOT harvest until 40 days after application. See remarks above on glufosinate ammonium and simazine alone.
glyphosate ROUNDUP (356g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	0.8 to 4.27 kg/ha 2.25 to 12 L/ha 2 to 4.5 kg/ha 2.25 to 5 kg/ha 2.5 to 5 kg/ha	0.9 to 4.8 L/ac 0.9 to 2 kg/ac 1 to 2 kg/ac	This tank mix will provide knockdown of emerged weeds and residual control of germinating weeds. See remarks on paraquat and simazine above, as well as "Notes on Chemicals" section.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	0.81 to 1.26 kg/ha 2.25 to 3.5 L/ha 2.25 to 3.5 L/ha 0.743 to 1.155 kg/ha 2.25 to 3.5 L/ha	0.9 to 1.4 L/ac 0.9 to 1.4 L/ac 0.9 to 1.4 L/ac 0.9 to 1.4 L/ac	Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use preemergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".

glyphosate ROUNDUP TRANSORB (360g/L)	1.71 to 2.52 kg/ha 4.75 to 7 L/ha	1.9 to 2.8 L/ac	To control quackgrass and Canada thistle. Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use pre-emergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".
GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	4.75 to 7 L/ha 1.568 to 2.31 kg/ha 4.75 to 7 L/ha	1.9 to 2.8 L/ac 1.9 to 2.8 L/ac	To control perennial weeds including poison ivy. Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use pre-emergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".
glyphosate ROUNDUP TRANSORB (360g/L)	2.52 to 4.32 kg/ha 7 to 12 L/ha	2.8 to 4.8 L/ac	
GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	7 to 12 L/ha 2.31 to 3.96 kg/ha 7 to 12 L/ha	2.8 to 4.8 L/ac 2.8 to 4.8 L/ac	
linuron LOROX DF (50 DF) AFOLAN F (480g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha	3.6 kg/ac 3.74 L/ac	Apply as directed spray before weeds are 10 cm high in 400-600 L/ha water (160-240 L/ac). Add a surfactant. Avoid contact with fruit, foliage or tree bark with spray or drift. Use only under trees established at least 10 years.
paraquat GRAMOXONE (200g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	Apply in 1100 L/ha (440 L/ac) water or apply 55 mL in 10 L of water sprayed to wet weed foliage. Use on trees established one year or more. Paraquat can be used in mixtures with terbacil, napropamide or simazine to provide residual vegetation control as well as a quick knockdown.
paraquat GRAMOXONE (200g/L) plus napropamide DEVIRINOL DF (50 DF)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	2.2 L/ac 3.6 kg/ac	Add DEVIRINOL to tank first then agitate and add GRAMOXONE. Apply in 1100 L/ha water (440 L/ac). Use on trees established one year or more.
paraquat GRAMOXONE (200g/L) plus simazine PRINCEP NINE-T (90WG)	1.1 kg/ha 5.5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha	2.2 L/ac 1 to 2 kg/ac	This tank mix will provide knockdown of emerged weeds and residual control of germinating weeds. See remarks on paraquat and simazine above, as well as "Notes on Chemicals" section.

## Apricots

**Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60-120 L/ac) water.**

**PREPLANT** - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

**PREPLANT INCORPORATED** - Two incorporations at right angles operating at a depth of 10 cm using a double disk (7-10 km/hour) or vibrating shank S-tine cultivator (10-13 km/hour) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

**PREEMERGENCE** - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of orchard.

metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	0.2 to 0.4 kg/ac	Apply as a preplant incorporated treatment in the year of planting only. Make single application as an orchard floor or planting row treatment. Consult label for incorporation instructions.
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metribuzin  
Apply and incorporate before planting trees. Apply once in the year of planting only.

SENCOR 75 DF (75 WG)	0.42 to 0.56 kg/ha 0.55 to 0.75 kg/ha	0.22 to 0.3 kg/ac
plus trifluralin	0.6 to 1.155 kg/ha	
TREFLAN (480g/L)	1.25 to 2.4 L/ha	0.5 to 0.96 L/ac
BONANZA 400 (400g/L)	1.5 to 2.75 L/ha	0.6 to 1.1 L/ac

napropamide  
Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make one application in the year of planting only.

DEVIRINOL 50W (50 WP)	4.5 kg/ha 9 kg/ha	3.6 kg/ac
plus terbacil	0.5 kg/ha	
SINBAR (80 WP)	0.63 kg/ha	0.25 kg/ac

napropamide  
Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make one application in the year of planting only.

DEVIRINOL DF (50 DF)	3.5 kg/ha 7 kg/ha	2.8 kg/ac
plus simazine	2 kg/ha	
PRINCEP NINE-T (90WG)	2.25 kg/ha	0.9 kg/ac

s-metolachlor  
Apply once in the year of planting. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees. Avoid contact with tree trunks and leaves.

DUAL MAGNUM (915g/L)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha	0.5 to 0.7 L/ac
plus simazine	1 to 2 kg/ha	
PRINCEP NINE-T (90WG)	1.1 to 2.2 kg/ha	0.44 to 0.88 kg/ac
SIMAZINE 80W (80WP)	1.25 to 2.5 kg/ha	0.5 to 1 kg/ac

simazine  
Apply once per season. Avoid contact with trunk and leaves of trees. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees.

PRINCEP NINE-T (90WG)	1 to 2 kg/ha	0.44 to 0.88 kg/ac
SIMAZINE 80W (80WP)	1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	0.5 to 1 kg/ac
trifluralin		
TREFLAN (480g/L)	0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha	0.5 to 0.96 L/ac
BONANZA 400 (400g/L)	1.5 to 2.75 L/ha	0.6 to 1.1 L/ac

### Planting (Postemergent Grass Herbicides)

Apply to actively growing annual grasses in the 2-5 leaf stage of growth.

fluazifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/ac
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Treat actively growing quackgrass at the 3-5 leaf stage.

fluazifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/ac
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sethoxydim  
Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.15 to 0.2 kg/ha 0.32 to 0.47 L/ha	0.13 to 0.19 L/ac
	2 L/ha	0.8 L/ac

sethoxydim  
Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.

POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.5 kg/ha 1.1 L/ha	0.45 L/ac
	2 L/ha	0.8 L/ac



Active ingredient  
TRADE NAME (Formulation)

RATE (active)  
PRODUCT PER HA

RATE PRODUCT  
PER ACRE

bentazon  
BASAGRAN (480g/L)  
plus surfactant/solvent  
MERGE  
0.84 to 1.08 kg/ha  
1.75 to 2.25 L/ha  
1 to 2 L/ha  
0.7 to 0.9 L/ac  
0.4 to 0.8 L/ac  
Direct under trees to small actively growing weeds. Avoid tree leaves. Apply in 100 to 400 L/ha water (40-160 L/ac) with at least 275 kPa pressure. Use lower rate of MERGE under hot, humid conditions. Two applications, 10 days apart at 1.75 L/ha (0.7 L/ac) may be applied in the year of planting only.

### Established Planting (Soil Applied Grass Herbicides)

s-metolachlor  
DUAL MAGNUM (915g/L)  
1.6 kg/ha  
1.75 L/ha  
0.7 L/ac  
Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.

### Established Planting (Soil Applied Broadleaf Herbicides)

metribuzin  
LEXONE DF (75 DF)  
0.75 kg/ha  
1 kg/ha  
0.4 kg/ac  
Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with tree trunks and leaves.

### Established Planting (Soil Applied Grass & Broadleaf Herbicides)

s-metolachlor  
DUAL MAGNUM (915g/L)  
plus metribuzin  
LEXONE DF (75 DF)  
1.6 kg/ha  
1.75 L/ha  
0.75 kg/ha  
1 kg/ha  
0.7 L/ac  
0.4 kg/ac  
Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.

s-metolachlor  
DUAL MAGNUM (915g/L)  
plus simazine  
PRINCEP NINE-T (90WG)  
1.6 kg/ha  
1.75 L/ha  
2.25 kg/ha  
2.5 kg/ha  
0.7 L/ac  
1 kg/ac  
Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter. Late season crabgrass and fall panicum may escape this treatment.

terbacil  
SINBAR (80 WP)  
plus metribuzin  
LEXONE DF (75 DF)  
0.5 kg/ha  
0.63 kg/ha  
0.75 kg/ha  
1 kg/ha  
0.25 kg/ac  
0.4 kg/ac  
Apply as a band under trees before weeds emerge. Use only one application per year. DO NOT USE on soil coarser than sandy loams with less than 3% organic matter.

### Established Planting (Postemergent Grass Herbicides)

fluzifop-p-butyl  
FUSILADE II (125g/L)  
0.125 kg/ha  
1 L/ha  
0.4 L/ac  
Apply to actively growing annual grasses at the 2 to 5 leaf stage of growth.

fluzifop-p-butyl  
FUSILADE II (125g/L)  
0.25 kg/ha  
2 L/ha  
0.8 L/ac  
Apply to emerged quackgrass at the 3 to 5 leaf stage of growth. Use only one application per year. Grasses emerging after the treatment will not be controlled.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE  
0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha  
2 L/ha  
0.13 to 0.19 L/ac  
0.8 L/ac  
Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE  
0.5 kg/ha  
1.1 L/ha  
2 L/ha  
0.45 L/ac  
0.8 L/ac  
Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.

To control broadleaf weeds including dandelions, and seedling Canada thistle and sow-thistle. Apply in early spring after weeds emerge (but no closer than 80 days to harvest), or postharvest to actively growing weeds. DO NOT apply when useable fruit is on the orchard floor.

2,4-D  
2,4-D AMINE 600 (560g/L) 0.952 kg/ha  
1.7 L/ha 0.68 L/ac

Use higher rates for perennial weeds - see "Apples" section. Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use preemergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".

glyphosate  
ROUNDUP TRANSORB  
(360g/L) 0.81 to 4.32 kg/ha  
2.25 to 12 L/ha 0.9 to 4.8 L/ac  
GLYFOS (360g/L) 2.25 to 12 L/ha 0.9 to 4.8 L/ac  
or glyphosate TMS 0.742 to 3.96 kg/ha  
TOUCHDOWN 480 (330g/L) 2.25 to 12 L/ha 0.9 to 4.8 L/ac

Apply in 1000 L/ha water (400 L/ac), or apply 55 mL in 10 L water sprayed to wet weed foliage. Use on trees established one year or more.

paraquat  
GRAMOXONE (200g/L) 1.1 kg/ha  
5.5 L/ha 2.2 L/ac

## Cherries & Plums

**Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60-120 L/ac) water.**

**PREPLANT** - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

**PREPLANT INCORPORATED** - Two incorporations at right angles operating at a depth of 10 cm using a double disk (7-10 km/hour) or vibrating shank S-tine cultivator (10-13 km/hour) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

**PREEMERGENCE** - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of orchard.

dichlobenil  
CASORON 4G (4 Gr) 4.4 to 7 kg/ha  
110 to 175 kg/ha 44 to 70 kg/ac

Apply before weeds emerge or after cultivation. 70 g of CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT apply until 4 weeks after transplanting. DO NOT use on light, sandy soil.

metribuzin  
LEXONE DF (75 DF) 0.38 to 0.75 kg/ha  
0.5 to 1 kg/ha 0.2 to 0.4 kg/ac

Registered on cherries only. Apply as a preplant incorporated treatment in the year of planting only. Make a single application as a broadcast treatment or within the planting row. Consult label for incorporation instructions.

metribuzin  
SENCOR 75 DF (75 WG)  
plus trifluralin 0.42 to 0.56 kg/ha  
0.55 to 0.75 kg/ha 0.22 to 0.3 kg/ac  
TREFLAN (480g/L) 0.6 to 1.155 kg/ha  
1.25 to 2.4 L/ha 0.5 to 0.96 L/ac  
BONANZA 400 (400g/L) 1.5 to 2.75 L/ha  
0.6 to 1.1 L/ac

Apply and incorporate before planting trees. Apply only once in the year of planting.

Active Ingredient, TRADE NAME (Formulation)	RATE (active) PRODUCT PER HA	RATE PRODUCT PER ACRE
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napropamide  
DEVINOL DF (50 DF)  
plus simazine  
PRINCEP NINE-T (90WG)

3.5 kg/ha  
7 kg/ha  
2 kg/ha  
2.25 kg/ha

2.8 kg/ac  
0.9 kg/ac

napropamide  
DEVINOL DF (50 DF)  
plus terbacil  
SINBAR (80 WP)

4.5 kg/ha  
9 kg/ha  
0.5 kg/ha  
0.63 kg/ha

3.6 kg/ac  
0.25 kg/ac

s-metolachlor  
DUAL MAGNUM (915g/L)  
plus simazine  
PRINCEP NINE-T (90WG)  
SIMAZINE 80W (80WP)

1.14 to 1.6 kg/ha  
1.25 to 1.75 L/ha  
1 to 2 kg/ha  
1.1 to 2.2 kg/ha  
1.25 to 2.5 kg/ha

0.5 to 0.7 L/ac  
0.44 to 0.88 kg/ac  
0.5 to 1 kg/ac

terbacil  
SINBAR (80 WP)

1 kg/ha  
1.25 kg/ha

0.5 kg/ac

trifluralin  
TREFLAN (480g/L)  
BONANZA 400 (400g/L)

0.6 to 1.155 kg/ha  
1.25 to 2.4 L/ha  
1.5 to 2.75 L/ha

0.5 to 0.96 L/ac  
0.6 to 1.1 L/ac

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha  
2 L/ha

0.13 to 0.19 L/ac  
0.8 L/ac

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.5 kg/ha  
1.1 L/ha  
2 L/ha

0.45 L/ac  
0.8 L/ac

bentazon  
BASAGRAN (480g/L)  
plus oil concentrate  
ASSIST

0.84 to 1.08 kg/ha  
1.75 to 2.25 L/ha  
1 to 2 L/ha

0.7 to 0.9 L/ac  
0.4 to 0.8 L/ac

established planting (soil applied grass herbicides)  
s-metolachlor  
DUAL MAGNUM (915g/L)

1.6 kg/ha  
1.75 L/ha

0.7 L/ac

established planting (soil applied broadleaf herbicides)

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.

metribuzin  
LEXONE DF (75 DF)

0.75 kg/ha  
1 kg/ha

0.4 kg/ac

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with tree trunks and leaves.

dichlobenil  
CASORON 4G (4 Gr)

4.4 to 7 kg/ha  
110 to 175 kg/ha

44 to 70 kg/ac

Apply in late fall or spring before weeds emerge. 70 g of CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT use on light, sandy soil.

linuron  
LOROX DF (50 DF)  
AFOLAN F (480g/L)  
LINURON 480 (480g/L)

4.5 kg/ha  
9 kg/ha  
9.36 L/ha  
9.36 L/ha

3.6 kg/ac  
3.74 L/ac  
3.74 L/ac

Apply in 400 to 600 L/ha water (160-240 L/ac) as directed spray before weeds are 10 cm high. Use only under trees established for 10 years. Keep spray off leaves and green bark of trees.

s-metolachlor  
DUAL MAGNUM (915g/L)  
plus metribuzin  
LEXONE DF (75 DF)

1.6 kg/ha  
1.75 L/ha  
0.75 kg/ha  
1 kg/ha

0.7 L/ac  
0.4 kg/ac

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.

s-metolachlor  
DUAL MAGNUM (915g/L)  
plus simazine  
PRINCEP NINE-T (90WG)

1.6 kg/ha  
1.75 L/ha  
2.25 kg/ha  
2.5 kg/ha

0.7 L/ac  
1 kg/ac

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter. Late season crabgrass and fall panicum may escape this treatment.

terbacil  
SINBAR (80 WP)  
plus metribuzin  
LEXONE DF (75 DF)

0.5 kg/ha  
0.63 kg/ha  
0.75 kg/ha  
1 kg/ha

0.25 kg/ac  
0.4 kg/ac

Registered on cherries only. Apply as a band under trees before weeds emerge. Use only one application per year. DO NOT USE on soil coarser than sandy loams with less than 3% organic matter.

fluzafop-p-butyl  
FUSILADE II (125g/L)

0.125 kg/ha  
1 L/ha

0.4 L/ac

Apply to actively growing annual grasses at the 2 to 5 leaf stage of growth.

fluzafop-p-butyl  
FUSILADE II (125g/L)

0.25 kg/ha  
2 L/ha

0.8 L/ac

Apply to emerged quackgrass at the 3 to 5 leaf stage of growth. Use only one application per year. Grasses emerging after the treatment will not be controlled.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha  
plus surfactant/solvent  
2 L/ha

0.13 to 0.19 L/ac  
0.8 L/ac

Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.5 kg/ha  
1.1 L/ha  
plus surfactant/solvent  
2 L/ha

0.45 L/ac  
0.8 L/ac

Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.



## PRECAUTIONS (For more information, see "Notes on Chemicals" section.)

Active Ingredient  
TRADE NAME (Formulation)

RATE (active)  
PRODUCT PER HA

RATE PRODUCT  
PER ACRE

2,4-D 0.952 kg/ha  
2,4-D AMINE 600 (560g/L) 1.7 L/ha

To control broad leaf weeds including dandelions, and seedling Canada thistle and sow-thistle. Apply in early spring after weeds emerge (but no closer than 80 days to harvest), or postharvest to actively growing weeds. DO NOT apply when useable fruit is on the orchard floor.

**Established Planting (Postemergent Grass & Broadleaf Herbicides)**

glufosinate ammonium IGNITE (150g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	1.08 to 2 L/ac	Registered on plums only. Apply as a directed spray before weeds are 30 cm high. Use 110-330 L/ha water (44-132 L/ac). Where weed growth is heavy, use the higher rate and larger water volume. DO NOT harvest until 40 days after application. For trees established at least one year.
glyphosate ROUNDUP TRANSORB (360g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	0.9 to 4.8 L/ac	Use higher rates for perennial weeds - see "Apples" section. Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use preemergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".
GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	2.25 to 12 L/ha 0.742 to 3.96 kg/ha 2.25 to 12 L/ha	0.9 to 4.8 L/ac  0.9 to 4.8 L/ac	Apply in 400 to 600 L/ha water (160-240 L/ac) as directed spray before weeds are 10 cm high. Use only under trees established for 10 years. Keep spray off leaves and green bark of trees.
linuron LOROX DF (50 DF) AFOLAN F (480g/L) LINURON 480 (480g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha 9.36 L/ha	3.6 kg/ac 3.74 L/ac 3.74 L/ac	Apply in 1000 L/ha water (400 L/ac), or apply 55 mL in 10 L water sprayed to wet weed foliage. Use on trees established one year or more. Under trees established at least 10 years, linuron can be tank mixed with paraquat to provide residual weed control.
paraquat GRAMOXONE (200g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	

**Grapes**

**Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60-120 L/ac) water.**

PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

PREEMERGENCE - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Cultural Weed Control - See CULTURAL WEED CONTROL IN FRUIT AND ORNAMENTAL CROPS

Hilling the vines at regular intervals throughout the year will aid in weed control. Be aware that this disruption of the soil will also disturb any residual herbicides. The use of cultivation, mulch or rye cover crops between the rows will provide better water penetration as well as aid in weed control.

Diuron, napropamide and simazine residues, high enough to harm many crops, can persist for several years after the removal of the vineyard.

**Established Grapevines (Soil Applied Grass & Broadleaf Herbicides)**

dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	44 to 70 kg/ac	Apply only to dormant healthy vines which have been established for at least 2 full years. Apply in late fall or spring before weeds emerge.
dichlobenil CASORON 4G (4 Gr)	7 to 9 kg/ha 175 to 225 kg/ha	70 to 90 kg/ac	Apply only to dormant, healthy vines that have been established at least two full years. Apply in late fall or spring before weeds emerge. For quackgrass, thistles, bindweed and perennial weeds.



diuron KARMEX (80 DF)	1.8 to 5.36 kg/ha 2.25 to 6.7 kg/ha	0.9 to 2.68 kg/ac	Use only in vineyards established for at least 3 years. Apply in at least 300 L/ha water (120 L/ac) actually sprayed. Apply as a directed spray to a 1 m strip under vines. Where weed growth is heavy, a rate of 4.5 kg/ha (1.8 kg/ac) KARMEX (80 DF) is usually sufficient, except on heavy clay soils or on soils with a high organic matter content. Then the rate should be increased to 6.7 kg/ha. A maintenance application of 2.25 kg/ha (0.9 kg/ac) KARMEX (80 DF) should be sufficient if applied before weed seeds germinate. Applications may be made in the spring or fall or both, but the total amount applied in one year should not exceed 4.5 kg/ha (1.8 kg/ac) KARMEX (80 DF), except on heavy clay or high organic matter soils as noted above. May be tank mixed with paraquat.
napropamide DEVIRINOL 50W (50 WP)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	Use only under vines which have been established at least one year. Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit and foliage.
simazine PRINCEP NINE-T (90WG) SIMADEX (500g/L) SIMAZINE 480 (480g/L)	3.6 to 4.5 kg/ha 4 to 5 kg/ha 7.2 to 9 L/ha 7.5 to 9.4 L/ha	1.6 to 2 kg/ac 2.9 to 3.6 L/ac 3 to 3.76 L/ac	Use only in vineyards established for at least 3 years. Apply in at least 300 L/ha water (120 L/ac) actually sprayed. Established dandelions, field bindweed and quackgrass will not be controlled. Should control plantain.
glufosinate ammonium IGNITE (150g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	1.08 to 2 L/ac	For vines established at least 3 years. Apply as a directed spray before annual weeds are 30 cm high. Avoid green bark. Use 110-330 L/ha water (44-132 L/ac). Where weed growth is heavy, use the higher rate and larger water volume. DO NOT harvest until 40 days after application.
glufosinate ammonium IGNITE (150g/L) plus simazine PRINCEP NINE-T (90WG) SIMADEX (500g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha 3.6 to 4.5 kg/ha 4 to 5 kg/ha 7.2 to 9 L/ha	1.08 to 2 L/ac 1.6 to 2 kg/ac 2.88 to 3.6 L/ac	Use as a directed spray avoiding green bark on vines established at least 3 years. For control of emerged annual weeds plus residual control of annual grasses and broadleaf weeds. DO NOT harvest until 40 days after application. See remarks above on IGNITE and simazine alone.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	0.81 to 1.26 kg/ha 2.25 to 3.5 L/ha 2.25 to 3.5 L/ha 0.742 to 1.155 kg/ha 2.25 to 3.5 L/ha	0.9 to 1.4 L/ac 0.9 to 1.4 L/ac 0.9 to 1.4 L/ac	For emerged annual grasses and broadleaves. DO NOT use on vines less than 3 years old. Apply in 200 to 300 L/ha water (80-120 L/ac) actually sprayed. Use preemergence herbicides to provide residual control of weed seedlings. DIRECT SPRAY TO AVOID LEAVES AND GREEN STEMS OF GRAPEVINES. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology". DO NOT use within 14 days of harvest. Use higher rate for larger annual weeds.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	1.71 to 4.32 kg/ha 4.75 to 12 L/ha 4.75 to 12 L/ha 1.565 to 3.96 kg/ha 4.75 to 12 L/ha	1.9 to 4.8 L/ac 1.9 to 4.8 L/ac 1.9 to 4.8 L/ac	For emerged quackgrass and broadleaf perennials. DO NOT use on vines less than 3 years old. Apply in 200 to 300 L/ha water (80-120 L/ac) actually sprayed. DIRECT SPRAY TO AVOID LEAVES AND GREEN STEMS OF GRAPEVINES. Use preemergence herbicides to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology". DO NOT use within 14 days of harvest. Apply at early bud stage of Canada thistle. Use lower rates for quackgrass and Canada thistle, higher rates for perennial broadleaf weeds and tall weed growth.

Use only in vineyards established at least 3 years. This tank mix will provide knockdown of emerged weeds and residual control of germinating weeds. Apply in at least 300 L/ha water (120 L/ac) actually sprayed. Direct spray to avoid leaves and green stems of grapevines. Use higher rates for perennial weeds and heavy weed infestations. DO NOT use within 14 days of harvest.

glyphosate ROUNDUP TRANSORB (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha 0.74 to 3.96 kg/ha 2.25 to 12 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 2.81 to 5.63 kg/ha	0.9 to 4.8 L/ac 0.9 to 4.8 L/ac 1 to 2 kg/ac 1.12 to 2.25 kg/ac
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Apply in 1000 L/ha water (400 L/ac) or apply 55 mL in 10 L water sprayed to wet weed foliage. Use on vines established on trellises. Paraquat can be used in a tank mix with diuron.

paraquat GRAMOXONE (200g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac
paraquat GRAMOXONE (200g/L) plus MCPB/MCPA (15:1) TROPOTOX PLUS (400g/L)	1.1 kg/ha 5.5 L/ha 1.1 kg/ha 2.75 L/ha	2.2 L/ac 1.1 L/ac

Apply in 1000 L/ha water (400 L/ac) or apply 55 mL GRAMOXONE plus 30 mL TROPOTOX PLUS in 10 L water per 100 m<sup>2</sup>. Apply in late May or early June, or for bindweed control, when bindweed starts to bloom. MCPB/MCPA SPRAY OR DRIFT CAN INJURE GRAPES. Use only when necessary as a spot treatment. Use a hand sprayer or a hand controlled wand fitted with a shielded nozzle. Use a low pressure, coarse spray and direct spray to avoid contact with leaves and stems of grape vines.

paraquat GRAMOXONE (200g/L) plus napropamide DEVIRINOL 50W (50 WP)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	2.2 L/ac 3.6 kg/ac
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## Peaches

Add DEVIRINOL to tank first then agitate and add GRAMOXONE. Apply in 1100 L/ha water (440 L/ac).

**Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60-120 L/ac) water.**  
PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

PREPLANT INCORPORATED - Two incorporations at right angles operating at a depth of 10 cm using a double disk (7-10 km/hour) or vibrating shank S-tine cultivator (10-13 km/hour) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

PREEMERGENCE - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of the orchard.

dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	44 to 70 kg/ac	Apply in late fall or spring before weeds emerge. 70 g of CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT apply until 4 weeks after transplanting. DO NOT use on light, sandy soil.
metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	0.2 to 0.4 kg/ac	Apply and incorporate before planting trees. Make a single application as a broadcast treatment or within the planting row. Consult label for incorporation instructions.

Apply and incorporate before planting trees. Apply once in the year of planting only as a broadcast treatment or within the planting row.

metribuzin  
SENCOR 75 DF (75 WG)  
plus trifluralin  
TREFLAN (480g/L)  
BONANZA 400 (400g/L)

0.42 to 0.56 kg/ha  
0.55 to 0.75 kg/ha  
0.6 to 1.155 kg/ha  
1.25 to 2.4 L/ha  
1.5 to 2.75 L/ha

0.22 to 0.3 kg/ac  
0.5 to 0.96 L/ac  
0.6 to 1.1 L/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make one application in the year of planting.

napropamide  
DEVIRINOL DF (50 DF)  
plus simazine  
PRINCEP NINE-T (90WG)

3.5 kg/ha  
7 kg/ha  
2 kg/ha  
2.25 kg/ha

2.8 kg/ac  
0.9 kg/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make one application in the year of planting.

napropamide  
DEVIRINOL DF (50 DF)  
plus terbacil  
SINBAR (80 WP)

4.5 kg/ha  
9 kg/ha  
0.5 kg/ha  
0.63 kg/ha

3.6 kg/ac  
0.25 kg/ac

Apply once in the year of planting. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees. Avoid contact with tree trunks and leaves.

s-metolachlor  
DUAL MAGNUM (915g/L)  
plus simazine  
PRINCEP NINE-T (90WG)  
SIMAZINE 80W (80WP)

1.14 to 1.6 kg/ha  
1.25 to 1.75 L/ha  
1 to 2 kg/ha  
1.1 to 2.2 kg/ha  
1.25 to 2.5 kg/ha

0.5 to 0.7 L/ac  
0.44 to 0.88 kg/ac  
0.5 to 1 kg/ac

Apply once per season. Avoid contact with trunk and leaves of trees. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees.

simazine  
PRINCEP NINE-T (90WG)  
SIMAZINE 80W (80WP)

1 to 2 kg/ha  
1.1 to 2.2 kg/ha  
1.25 to 2.5 kg/ha

0.44 to 0.88 kg/ac  
0.5 to 1 kg/ac

Apply after planting trees, before weeds emerge. DO NOT use on soils with less than 2% organic matter. Avoid contact with tree trunks and leaves.

terbacil  
SINBAR (80 WP)

1 kg/ha  
1.25 kg/ha

0.5 kg/ac

Apply and incorporate before planting trees. Use at least 100 L/ha water (40 L/ac). Apply once in the year of planting only as a broadcast treatment or within the planting row.

trifluralin  
TREFLAN (480g/L)  
BONANZA 400 (400g/L)

0.6 to 1.155 kg/ha  
1.25 to 2.4 L/ha  
1.5 to 2.75 L/ha

0.5 to 0.96 L/ac  
0.6 to 1.1 L/ac

Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha  
2 L/ha

0.13 to 0.19 L/ac  
0.8 L/ac

Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.5 kg/ha  
1.1 L/ha  
2 L/ha

0.45 L/ac  
0.8 L/ac

Active ingredient  
TRADE NAME (Formulation)

RATE (active)  
PRODUCT PER HA

RATE PRODUCT  
PER ACRE

Direct under trees to small actively growing weeds. Avoid tree leaves. Apply in 100 to 400 L/ha water (40-160 L/ac) with at least 275 kPa pressure. Use lower rate of ASSIST under hot, humid conditions. Two applications, 10 days apart at 1.75 L/ha (0.7 L/ac) may be applied in the year of planting only.

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with tree trunks and leaves.

Apply in late fall or spring before weeds emerge. 70 g CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT use on light, sandy soil.

Apply in 400 to 600 L/ha water (160-240 L/ac) as a directed spray before weeds are 12 cm high. Use only under peach trees established for over one year. Keep spray off leaves, fruit and green bark of trees. Add a surfactant.

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit and foliage.

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.

Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter. Late season crabgrass and fall panicum may escape this treatment.

Apply in 1000 L/ha of water (400 L/ac). Use only under trees established for at least 3 years. Apply as a band under the trees before weeds emerge. DO NOT use on soils with less than 3% organic matter.

Apply as a band under trees before weeds emerge. Use only one application per year. DO NOT USE on soil coarser than sandy loams with less than 3% organic matter.

## Essential Planting (Postemergent Grass Herbicides)



fluzifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/ac	Apply to actively growing annual grasses at the 2 to 5 leaf stage of growth. Use only one application per year. Grasses emerging after the treatment will not be controlled.
fluzifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/ac	Apply to emerged quackgrass at the 3 to 5 leaf stage of grass. Use only one application per year. Grasses emerging after the treatment will not be controlled.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.15 to 0.2 kg/ha 0.32 to 0.47 L/ha 2 L/ha	0.13 to 0.19 L/ac 0.8 L/ac	Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.5 kg/ha 1.1 L/ha 2 L/ha	0.45 L/ac 0.8 L/ac	Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.
2,4-D 2,4-D AMINE 600 (560 g/L)	0.952 kg/ha 1.7 L/ha	0.68 L/ac	To control emerged broad leaf weeds including dandelions, and seedling Canada thistle and sow-thistle. Apply in early spring after weeds emerge (but no closer than 80 days to harvest), or postharvest to actively growing weeds. DO NOT apply when useable fruit is on the orchard floor.
glufosinate ammonium IGNITE (150g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	1.08 to 2 L/ac	Apply as a directed spray before weeds are 30 cm high, avoiding green bark. Use 110-330 L/ha water (44-132 L/ac). Where weed growth is heavy, use the higher rate and larger water volume. DO NOT harvest until 40 days after application. For trees established at least one year.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha 2.25 to 12 L/ha 0.74 to 3.96 kg/ha 2.25 to 12 L/ha	0.9 to 4.8 L/ac 0.9 to 4.8 L/ac 0.9 to 4.8 L/ac	Use higher rates for perennial weed - see "Apples" section. Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use preemergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".
linuron LOROX DF (50 DF) AFOLAN F (480g/L)	4.52 kg/ha 9 kg/ha 9.36 L/ha	3.6 kg/ac 3.74 L/ac	Apply in 400 to 600 L/ha water (160-240 L/ac) as a directed spray before weeds are 12 cm high. Use only under peach trees established for over one year. Keep spray off leaves, fruit and green bark of trees. Add a surfactant.
paraquat GRAMOXONE (200g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	Apply in 1000 L/ha water (400 L/ac), or apply 55 mL in 10 L water sprayed to wet weed foliage. Use on trees established one year or more.
paraquat GRAMOXONE (200g/L) plus napropamide DEVIRINOL DF (50 DF)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	2.2 L/ac 3.6 kg/ac	Add DEVIRINOL to tank first then agitate and add GRAMOXONE. Apply in 1100 L/ha water (440 L/ac).
Pears			

Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60-120 L/ac) water.



**PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.**

**PREPLANT INCORPORATED** - Two incorporations at right angles operating at a depth of 10 cm using a double disk (7-10 km/hour) or vibrating shank S-tine cultivator (10-13 km/hour) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

**PREEMERGENCE** - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of the orchard.

dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	44 to 70 kg/ac	Apply in late fall or spring before weeds emerge. 70 g of CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT apply until 4 weeks after transplanting. DO NOT use on light, sandy soil.
metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	0.2 to 0.4 kg/ac	Apply and incorporate before planting trees. Make a single application as a broadcast treatment or within the planting row. Consult label for incorporation instructions.
metribuzin SENCOR 75 DF (75 WG) plus trifluralin TREFLAN (480g/L) BONANZA 400 (400g/L)	0.42 to 0.56 kg/ha 0.55 to 0.75 kg/ha 0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	0.22 to 0.3 kg/ac 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	Apply and incorporate before planting trees. Apply once in the year of planting as a broadcast treatment or within the planting row.
napropamide DEVINOL DF (50 DF) plus simazine PRINCEP NINE-T (90WG)	3.5 kg/ha 7 kg/ha 2 kg/ha 2.25 kg/ha	2.8 kg/ac 0.9 kg/ac	Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make one application in the planting year.
napropamide DEVINOL DF (50 DF) plus terbacil SINBAR (80 WP)	4.5 kg/ha 9 kg/ha 0.5 kg/ha 0.63 kg/ha	3.6 kg/ac 0.25 kg/ac	Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Make one application in the year of planting.
s-metolachlor DUAL MAGNUM (915g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha 1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	0.5 to 0.7 L/ac 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	Apply once in the year of planting. DO NOT use on sandy soils with less than 2% organic matter. Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees. Avoid contact with tree trunks and leaves.
terbacil SINBAR (80 WP)	1 kg/ha 1.25 kg/ha	0.5 kg/ac	Apply after planting trees, before weeds emerge. DO NOT use on soils with less than 2% organic matter. Avoid contact with tree trunks and leaves.
trifluralin TREFLAN (480g/L) BONANZA 400 (400g/L)	0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	Apply and incorporate before planting trees. Use at least 100 L/ha water (40 L/ac). Apply once in the year of planting only as a broadcast treatment or within the planting row.

Apply to actively growing annual grasses in the 2-5 leaf stage of growth.

fluzifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/ac	Apply to actively growing quackgrass in the 3-5 leaf stage of growth.
fluzifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/ac	Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.15 to 0.2 kg/ha 0.32 to 0.47 L/ha 2 L/ha	0.13 to 0.19 L/ac 0.8 L/ac	Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.84 to 1.08 kg/ha 1.75 to 2.25 L/ha 1 to 2 L/ha	0.7 to 0.9 L/ac 0.4 to 0.8 L/ac	Direct under trees to small actively growing weeds. Avoid tree leaves. Apply in 100 to 400 L/ha water (40-160 L/ac) with at least 275 kPa pressure. Use lower rate of ASSIST under hot, humid conditions. Two applications, 10 days apart at 1.75 L/ha (0.7 L/ac) may be applied in the year of planting only.
propyzamide KERB (50 WP)	2.25 kg/ha 4.5 kg/ha	1.8 kg/ac	Apply from late September to early November when soil is cool and moist but not frozen. Use only under pear trees established for at least one year. 4.5 kg/ha is equivalent to 45 g/100 m <sup>2</sup> .
s-metolachlor DUAL MAGNUM (915g/L)	1.6 kg/ha 1.75 L/ha	0.7 L/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.
metribuzin LEXONE DF (75 DF)	0.75 kg/ha 1 kg/ha	0.4 kg/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with tree trunks and leaves.
dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	44 to 70 kg/ac	Apply in late fall or spring before weeds emerge. 70 g of CASORON 4 G applied in an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). DO NOT use on light, sandy soils.
linuron LOROX DF (50 DF) AFOLAN F (480g/L) LINURON 480 (480g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha 9.36 L/ha	3.6 kg/ac 3.74 L/ac 3.74 L/ac	Apply a directed spray before weeds are 10 cm high in 400 to 600 L/ha water (160-240 L/ac). Add a surfactant. Use only under pear trees established at least 10 years. Avoid contact with fruit, foliage or green bark with spray or drift.
napropamide DEVIRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit and foliage. Use only under trees established for at least one year.

PRECAUTIONS: For more information see "Notes on Chemicals" section.

Active ingredient TRADE NAME Formulation	RATE active PRODUCT PER HA	RATE PRODUCT PER ACRE	
s-metolachlor DUAL MAGNUM (915g/L) plus metribuzin LEXONE DF (75 DF)	1.6 kg/ha 1.75 L/ha 0.75 kg/ha 1 kg/ha	0.7 L/ac 0.4 kg/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter.
s-metolachlor DUAL MAGNUM (915g/L) plus simazine PRINCEP NINE-T (90WG)	1.6 kg/ha 1.75 L/ha 2.25 kg/ha 2.5 kg/ha	0.7 L/ac 1 kg/ac	Apply once per year as a band treatment under the trees before weeds emerge. Avoid contact with trunk and leaves of trees. DO NOT USE on sandy soil with less than 2% organic matter. Late season crabgrass and fall panicum may escape this treatment.
simazine PRINCEP NINE-T (90WG) SIMADEX (500g/L) SIMAZINE 480 (480g/L)	2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha 4.7 to 9.4 L/ha	1 to 2 kg/ac 1.8 to 3.6 L/ac 1.88 to 3.76 L/ac	Apply in 300 to 1000 L/ha water (120-400 L/ac). Use only under trees planted for one year or more.
terbacil SINBAR (80 WP) plus metribuzin LEXONE DF (75 DF)	0.5 kg/ha 0.63 kg/ha 0.75 kg/ha 1 kg/ha	0.25 kg/ac 0.4 kg/ac	Apply as a band under trees before weeds emerge. Use only one application per year. DO NOT USE on soil coarser than sandy loams with less than 3% organic matter.
fluzifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/ac	Apply to actively growing annual grasses in the 2-5 leaf stage of growth.
fluzifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/ac	Apply to actively growing quackgrass in the 3-5 leaf stage of growth.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.15 to 0.2 kg/ha 0.32 to 0.47 L/ha 2 L/ha	0.13 to 0.19 L/ac 0.8 L/ac	Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.
sethoxydim POAST ULTRA (450g/L) plus surfactant/solvent MERGE	0.5 kg/ha 1.1 L/ha 2 L/ha	0.45 L/ac 0.8 L/ac	Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.
2,4-D 2,4-D AMINE 600 (560 g/L)	0.952 kg/ha 1.7 L/ha	0.68 L/ac	To control emerged broadleaf weeds including dandelions, and seedling Canada thistle and sow-thistle. Apply in early spring after weeds emerge (but no closer than 80 days to harvest), or postharvest to actively growing weeds. DO NOT apply when useable fruit is on the orchard floor.
glufosinate ammonium IGNITE (150g/L)	0.405 to 0.705 kg/ha 2.7 to 5 L/ha	1.08 to 2 L/ac	Apply as a directed spray before weeds are 30 cm high. Use 110-330 L/ha water (44-132 L/ac). Where weed growth is heavy, use the higher rate and larger water volume. DO NOT harvest until 40 days after application. For trees established at least one year.

glufosinate ammonium IGNITE (150g/L) plus simazine PRINCEP NINE-T (90W/G) SIMADEX (500g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha	1.08 to 2 L/ac 1 to 2 kg/ac 1.8 to 3.6 L/ac	For control of emerged weeds less than 30 cm high plus residual control of annual grasses and broadleaf weeds. Use as a directed spray around the bases of trees established at least one year. DO NOT harvest until 40 days after application. Apply in 330 L/ha water (132 L/ac). Use higher rates where weed growth is heavy.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L) or glyphosate TMS TOUCHDOWN 480 (330g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha 2.25 to 12 L/ha 0.742 to 3.96 kg/ha 2.25 to 12 L/ha	0.9 to 4.8 L/ac 0.9 to 4.8 L/ac 0.9 to 4.8 L/ac 0.9 to 4.8 L/ac	Use higher rates for perennial weed - see "Apples" section. Apply in 200 to 300 L/ha water (80-120 L/ac). Remove all suckers from base of trunks before application. Apply as a directed spray. DO NOT apply to trees with "green" bark in the area of application. DO NOT apply within 30 days before harvest. Use preemergence herbicide to provide residual control of weed seedlings. For information on spot handgun treatment, see "Special Methods of Weed Control". Wiper applicators may also be used - see "Application Technology".
linuron LOROX DF (50 DF) AFOLAN F (480g/L) LINURON 480 (480g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha 9.36 L/ha	3.6 kg/ac 3.74 L/ac 3.74 L/ac	Apply as a directed spray before weeds are 10 cm high in 400 to 600 L/ha water (160-240 L/ac). Add a surfactant. Use only under pear trees established at least 10 years. Avoid contact with fruit, foliage or green bark with spray or drift.
paraquat GRAMOXONE (200g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	Apply in 1000 L/ha water (400 L/ac) or apply 55 mL in 10 L water sprayed to wet weed foliage. Use on trees established one year or more.
paraquat GRAMOXONE (200g/L) plus napropamide DEVIRINOL DF (50 DF)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	2.2 L/ac 2.2 L/ac 3.6 kg/ac	Add DEVIRINOL to tank first then agitate and add GRAMOXONE. Apply in 1100 L/ha water (440 L/ac).
paraquat GRAMOXONE (200g/L) plus simazine PRINCEP NINE-T (90W/G)	1.1 kg/ha 5.5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha	2.2 L/ac 1 to 2 kg/ac	This tank mix will provide knockdown of emerged weeds and residual control of germinating weeds. Apply in 1000 L/ha water (400 L/ac). Use only under trees established for at least one year.

### Blueberries, Highbush

Recommended rates /ha or /ac refer to area actually treated with herbicide.

#### CULTURAL WEED CONTROL-SEE NOTES ON CULTURAL WEED CONTROL IN FRUIT & ORNAMENTALS SECTION.

A biodegradable mulch could be used for weed control within the plant row. Sawdust mulch will assist in weed control if it is applied early in the season before the weed seeds germinate. Apply old sawdust 5 cm thick. The mulch will not prevent the germination of weed seeds that may blow onto the surface of the mulch.

In subsequent years, the organic matter in the mulch may tie up and thus reduce the effectiveness of certain residual herbicides.

The nitrogen requirements of the crop will change as the mulch is degraded. Initially, nitrogen will be consumed by microorganisms, thus necessitating higher rates of nitrogen fertilizer. Later, as the sawdust is degrading, nitrogen will be released and the crop may require less nitrogen fertilizer than an unmulched crop. It may take 2 years or more for sawdust mulch to significantly decompose. Adjust fertilizer rates according to mulch breakdown, plant growth and leaf nutrient analysis results.

PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

PREEMERGENCE - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.



Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of orchard.

napropamide  
DEVIRINOL DF (50 DF) 4.5 kg/ha  
9 L/ha 3.6 L/ac

Incorporation by rainfall or irrigation is essential. Apply once per season, either in the fall or spring, before weeds emerge. DO NOT apply to frozen ground.

Apply prebloom in the spring to actively growing annual grass at the 2-6 leaf stage.

fluazifop-p-butyl  
FUSILADE II (125g/L) 0.15 kg/ha  
1.2 L/ha 0.48 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth.

fluazifop-p-butyl  
FUSILADE II (125g/L) 0.25 kg/ha  
2 L/ha 0.8 L/ac

Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE 0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha  
2 L/ha 0.13 to 0.19 L/ac  
0.8 L/ac

Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE 0.5 kg/ha  
1.1 L/ha  
2 L/ha 0.45 L/ac  
0.8 L/ac

For control of emerged vetch and red and white clover. Make one application per year. Use lower rate for vetch and high rate for clover. The preharvest interval is 45 days.

clpyralid  
LONTREL 360 (360g/L) 0.15 to 0.3 kg/ha  
0.42 to 0.83 L/ha 0.17 to 0.33 L/ac

### Use of Planting (Postemergent Grass & Broadleaf Herbicide)

Apply as a directed spray in 200 to 300 L/ha water (80-120 L/ac), using no more than 275 kPa pressure. Avoid contact with fruit, foliage or canes. Use only one application per season, no closer than 30 days to harvest.

glyphosate  
ROUNDUP TRANSORB  
(360g/L) 1 to 2 kg/ha  
2.8 to 5.6 L/ha 1.12 to 2.24 L/ac  
GLYFOS (360g/L) 2.8 to 5.6 L/ha 1.12 to 2.24 L/ac  
or glyphosate TMS 0.927 to 1.84 kg/ha  
TOUCHDOWN 480 (330g/L) 2.8 to 5.6 L/ha 1.12 to 2.24 L/ac

### Established Planting (Soil Applied Grass & Broadleaf Herbicide)

Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge. If air temps are too warm (above 10-15 C) volatilization can occur causing plant injury. 70 g CASORON 4 G applied to an area 2 x 2 m is equivalent to 175 kg/ha (70 kg/ac). Use only under plants established for at least 3 years. DO NOT use on light, sandy soil.

dichlobenil  
CASORON 4G (4 Gr) 7 to 9 kg/ha  
175 to 225 kg/ha 70 to 90 kg/ac

Incorporation by rainfall or irrigation is essential. Apply once per season, either in the fall or spring, before weeds emerge. DO NOT apply to frozen ground. DO NOT apply within 70 days of harvest.

napropamide  
DEVIRINOL DF (50 DF) 4.5 kg/ha  
9 kg/ha 3.6 kg/ac

simazine	2.25 to 3.38 kg/ha	1 to 1.5 kg/ac	Apply in 300 to 1000 L/ha water (120-400 L/ac) before weed emergence. Use only on established plants.
PRINCEP NINE-T (90WG)	2.5 to 3.75 kg/ha	1.1 to 1.7 kg/ac	
SIMAZINE 80W (80WP)	2.75 to 4.25 kg/ha		
terbacil	2.2 to 3.4 kg/ha		
SINBAR (80 WP)	2.75 to 4.25 kg/ha	1.1 to 1.7 kg/ac	Apply in 200 to 1000 L/ha water (80-400 L/ac). Use only in plantings established in the field for at least one year. Make one application per year. Injury may occur on sandy soil even with the low rate. Use the high rate only on muck or peat soils where experience has shown this to be a safe practice.
fluazifop-p-butyl	0.125 kg/ha	0.4 L/ac	Apply to actively growing annual grasses in the 2-5 leaf stage of growth.
FUSILADE II (125g/L)	1 L/ha		
fluazifop-p-butyl	0.25 kg/ha	0.8 L/ac	Apply to actively growing quackgrass in the 3-5 leaf stage of growth.
FUSILADE II (125g/L)	2 L/ha		
sethoxydim	0.15 to 0.2 kg/ha		Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.
POAST ULTRA (450g/L)	0.32 to 0.47 L/ha	0.13 to 0.19 L/ac	
plus surfactant/solvent			
MERGE	2 L/ha	0.8 L/ac	
sethoxydim	0.5 kg/ha		Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.
POAST ULTRA (450g/L)	1.1 L/ha	0.45 L/ac	
plus surfactant/solvent			
MERGE	2 L/ha	0.8 L/ac	
clopyralid	0.15 to 0.3 kg/ha		Make one application per year. Use lower rate for vetch and high rate for clover. The preharvest interval is 45 days.
LONTREL 360 (360g/L)	0.42 to 0.83 L/ha	0.17 to 0.33 L/ac	
glyphosate	1 to 2 kg/ha		Apply as a directed spray in 200 to 300 L/ha water (80-120 L/ac), using no more than 275 kPa pressure. Avoid contact with fruit, foliage or canes. Use only one application per season, no closer than 30 days to harvest.
ROUNDUP TRANSORB (360g/L)	2.8 to 5.6 L/ha	1.12 to 2.24 L/ac	
GLYFOS (360g/L)	2.8 to 5.6 L/ha	1.12 to 2.24 L/ac	
or glyphosate TMS	0.927 to 1.84 kg/ha		
TOUCHDOWN 480 (330g/L)	2.8 to 5.6 L/ha	1.12 to 2.24 L/ac	
paraquat	1.1 kg/ha		Apply in 1000 L/ha water (400 L/ac) or apply 55 mL of product in 10 L of water sprayed to wet weed foliage. Use on plantings established one year.
GRAMOXONE (200g/L)	5.5 L/ha	2.2 L/ac	
paraquat	1.1 kg/ha		This tank mix will provide knockdown of emerged weeds and residual control of germinating weeds. Apply as a directed spray to established plantings. Use 1000 L/ha water (400 L/ac) to wet weed foliage.
GRAMOXONE (200g/L)	5.5 L/ha	2.2 L/ac	
plus simazine	2.25 to 3.38 kg/ha		
PRINCEP NINE-T (90WG)	2.5 to 3.75 kg/ha	1 to 1.5 kg/ac	

Cranberries



Maintaining a healthy and vigorous crop will aid in weed control by avoiding openings in the bed for weed germination and establishment.

Prevent weeds from setting seed on dikes and in adjacent uncropped areas by using cultural or chemical weed control measures. Mowing at regular intervals will prevent many weeds from setting seed. Seeding the dikes with a desirable grass cover will reduce the opportunities for weed establishment and will provide bank stabilization.

PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

PREEMERGENCE - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

dichlobenil  
CASORON 4G (4 Gr) 4.4 kg/ha  
110 kg/ha 44 kg/ac

Controls annual broadleaf species, certain sedges and Juncus species. Apply in early spring, pre-bloom. Temporary reddening of plants may occur, especially with late spring applications. DO NOT use on new plantings or on newly sanded beds or on beds recently mowed for vines. Use lower rates of application on sandy bogs.

Do not use on new beds. Apply once per year in spring and irrigate immediately.

napropamide  
DEVIRINOL 10G (10%) 4.5 to 6.7 kg/ha  
45 to 67 L/ha 18 to 26.8 L/ac

Apply to actively growing annual grasses in the 2-5 leaf stage of growth.

fluzifop-p-butyl  
FUSILADE II (125g/L) 0.125 kg/ha  
1 L/ha 0.4 L/ac

For non-bearing cranberries. Apply to actively growing quackgrass in the 3-5 leaf stage of growth. Use only one application per season.

fluzifop-p-butyl  
FUSILADE II (125g/L) 0.25 kg/ha  
2 L/ha 0.8 L/ac

Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent 0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha 0.13 to 0.19 L/ac

Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent 0.5 kg/ha  
1.1 L/ha 0.45 L/ac

MERGE 2 L/ha 0.8 L/ac

## Broadleaf Herbicides

Controls emerged annual and perennial weeds, including hardhack, St. John's Wort, Alder, Purple Aster. Use a 33 % solution with a ropewick or other wiper. Apply as an over the top application to actively growing weeds (June-July). Injury will result if crop is contacted. Use one application per year, no closer than 50 days before harvest.

2,4-D 0.47 kg/2L water  
2,4-D AMINE 500 (470g/L) 1 L/2 L water

clopyralid  
LONTREL 360 (360g/L)  
7.2 g/L water  
20 mL/L water

Controls emerged vetch. Apply this 2% solution with wiper-type equipment onto weed foliage that extends above the cranberry canopy. Wiper application may be made in the fall at least 2 weeks after harvest, after the vines have attained their winter dormancy colour. Spring applications can be made prior to bud-break, and again until growth is 1-2 mm long. Avoid contact with cranberry shoots after growth begins. Do not use more than 2 applications a year, no closer than 60 days to harvest.

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)  
0.36 kg/4L of water  
1 L/4L of water  
1 L/4L of water

Use a 20% solution. Apply with a rope wick or other similar device. Refer to section on SELECTIVE WEED CONTROL WITH WIPER APPLICATORS. Avoid contact with the cranberry vines.

## Currents and Gooseberries

**Recommended rates /ha or /ac refer to area actually treated with herbicide.**

Cultural Weed Control - See notes on CULTURAL WEED CONTROL IN FRUIT AND ORNAMENTAL CROPS section.

There are no herbicides registered for preemergence weed control in currants and gooseberries. A biodegradable mulch could be used for weed control in the planting strip. A straw mulch will assist in weed control within the row if it is applied early in the season before the weed seeds germinate. Use mulch that is free of weed seeds and ensure that enough nitrogen is provided for the crop.

PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

paraquat  
GRAMOXONE (200g/L)  
1.1 kg/ha  
5.5 L/ha  
2.2 L/ac

Apply in 1000 L/ha water (400 L/ac) or apply 55 mL of water as a spot treatment, sprayed to wet weed foliage. Direct the spray to wet the weeds but avoid wetting the leaves or green bark of the bushes.

## Raspberries (Caneberries And Blackberries)

**Recommended rates /ha or /ac refer to area actually treated with herbicide.**

PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

PREEMERGENCE - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

napropamide  
DEVIRINOL DF (50DF)  
4.5 kg/ha  
9 L/ha  
3.6 L/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. May be used on new or established plantings. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit or foliage.

fluzifop-p-butyl  
FUSILADE II (125g/L)  
0.15 kg/ha  
1.2 L/ha  
0.48 L/ac

Apply to actively growing annual grasses in the 2-5 leaf stage of growth.

fluzifop-p-butyl  
FUSILADE II (125g/L)  
0.25 kg/ha  
2 L/ha  
0.8 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth.

Use the amine formulation. Apply in 100 to 200 L/ha water (40-80 L/ac) actually sprayed. DO NOT spray when plants are in bloom. Keep spray off new shoots as much as possible. Spot spraying at a rate equivalent to 1 kg ai/ha (0.4 kg ai/ac) may be necessary to control established dandelions and other broadleaf weeds.

2,4-D \*  
2,4-D (470g/L)

0.55 kg/ha  
1.2 L/ha

0.48 L/ac

Apply in 1000 L/ha water (400 L/ac) or apply 55 mL in 10 L water sprayed to wet weed foliage. Direct spray at base of canes in the spring before new shoots emerge.

paraquat  
GRAMOXONE (200g/L)

1.1 kg/ha  
5.5 L/ha

2.2 L/ac

70 g CASORON 4 G applied to an area of 2x2m is equivalent to 175 kg/ha (70 kg/ac). Apply on established raspberry plantings in late fall. DO NOT cultivate or work into the soil. DO NOT APPLY IN THE SPRING as injury may result.

dichlobenil  
CASORON 4G (4 Gr)

7 kg/ha  
175 kg/ha

70 kg/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. May be used on new or established plantings. Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit or foliage.

napropamide  
DEVIRINOL DF (50 DF)

4.5 kg/ha  
9 kg/ha

3.6 kg/ac

Apply in 300 to 1000 L/ha water (120-400 L/ac) actually sprayed. Apply as a directed spray early in the spring before the weeds emerge. Keep spray off young shoots. DO NOT use in first year plantings.

simazine  
PRINCEP NINE-T (90WG)  
SIMADEX (500g/L)  
SIMAZINE 480 (480g/L)

1.8 to 2.25 kg/ha  
2 to 2.5 kg/ha  
3.6 to 4.5 L/ha  
3.8 to 4.7 L/ha

0.8 to 1 kg/ac  
1.44 to 1.8 L/ac  
1.52 to 1.88 L/ac

## Established Planting (Postemergent Grass Herbicides)

Apply to actively growing annual grasses in the 2-5 leaf stage of growth.

fluzifop-p-butyl  
FUSILADE II (125g/L)

0.125 kg/ha  
1 L/ha

0.4 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth.

fluzifop-p-butyl  
FUSILADE II (125g/L)

0.25 kg/ha  
2 L/ha

0.8 L/ac

Apply to emerged annual grasses in the 1-6 leaf stage during active growth. Complete grass control is normally obtained in 7 to 21 days after application. Use the low rate for annual grasses and the high rate for volunteer grains.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.15 to 0.2 kg/ha  
0.32 to 0.47 L/ha

0.13 to 0.19 L/ac

0.8 L/ac

Apply to emerged quackgrass up to the 3 leaf stage during active growth. Complete grass control is normally obtained 7 to 21 days after application.

sethoxydim  
POAST ULTRA (450g/L)  
plus surfactant/solvent  
MERGE

0.5 kg/ha  
1.1 L/ha

0.45 L/ac

## Established Planting (Postemergent Broadleaf Herbicides)

2,4-D \*

0.55 kg/ha

0.48 L/ac

Use the amine formulation. Apply in 100 to 200 L/ha water (40-80 L/ac) actually sprayed. DO NOT spray when plants are in bloom. Keep spray off new shoots as much as possible. Spot spraying at a rate equivalent to 1 kg ai/ha (0.4 kg ai/ac) may be necessary to control established dandelions and other broadleaf weeds.

2,4-D (470g/L)

1.2 L/ha

## Established Planting (Postemergent Grass & Broadleaf Herbicides)

glufosinate ammonium  
IGNITE (150g/L)

1 kg/ha  
6.67 L/ha

2.7 L/ac

For use in the production year of raspberries grown in the biennial production system, or in a planting that will be removed after harvest. Do not apply to immature and weak plantings. Apply when shoots are 10 to 20 cm tall to suppress the emerged flush of primocanes, and control any weeds emerged at time of treatment. Apply in a minimum of 330 L water/ha ( 132 L/ac), avoiding drift onto green tissue of floricanes.

paraquat  
GRAMOXONE (200g/L)

1.1 kg/ha  
5.5 L/ha

2.2 L/ac

Apply in 1000 L/ha water (400 L/ac) or apply 55 mL in 10 L water sprayed to wet weed foliage. Direct spray at base of canes in the spring before new shoots emerge.

paraquat

GRAMOXONE (200g/L)

1.1 kg/ha  
5.5 L/ha

2.2 L/ac

This tank mix will provide knockdown of emerged weeds and residual control of germinating weeds on established plantings. DO NOT spray young raspberry shoots. Apply in 1000 L/ha water (400 L/ac) to wet weed foliage.

plus simazine  
PRINCEP NINE-T (90WG)

1.8 to 2.25 kg/ha  
2 to 2.5 kg/ha

0.8 to 1 kg/ac

## Strawberries - First (Planting) Year

**Recommended rates /ha or /ac refer to area actually treated with herbicide.**

Cultural Weed Control - See CULTURAL WEED CONTROL IN FRUIT AND ORNAMENTAL CROPS section.

Use straw mulch which is free of weed seed in strawberries so that weeds are not imported into the crop. The mulch should be spread between the rows when it is pulled off the plants in the spring to provide additional weed control.

PREPLANT - See under PREPLANT - SITE PREPARATION for details of products, rates and remarks.

PREEMERGENCE - Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Simazine, napropamide and terbacil residues, high enough to harm many crops, may persist for several years after removal of orchard.

## Before Planting (Soil Applied Grass and Broadleaf Herbicides)

trifluralin

0.6 to 1.155 kg/ha

0.5 to 0.96 L/ac

Apply preemergence to the weeds or following a clean cultivation. Immediate incorporation in 2 directions is essential. May be applied and incorporated 1 day to 3 weeks before planting. May delay establishment under stressful conditions.

TREFLAN (480g/L)

1.25 to 2.4 L/ha

0.4 to 0.76 kg/ac

RIVAL DF (60 DF)

1 to 1.9 kg/ha

0.6 to 1.1 L/ac

BONANZA 400 (400g/L)

1.5 to 2.75 L/ha

## 2-4 Weeks After Planting (Soil Applied Grass and Broadleaf Herbicides)



Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT PER HA	RATE PRODUCT PER ACRE
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napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/acre
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Apply preemergent to weeds or following a cultivation. Incorporation by cultivation or rainfall or irrigation is essential. Where daughter plant establishment is important, (e.g., for plant producers) delay application until desired number of daughter plants have been established. Inhibition of daughter plant roots can occur where soil moisture is low and will be minimized if irrigation is applied shortly after application. See "Notes on Chemicals" section. Use only one application per season.

### 2-4 Weeks After Planting (Postemergence Grass Herbicides)

fluzifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/acre
fluzifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/acre

Apply to actively growing annual grasses in the 2-5 leaf stage of growth. Use only one application per season. Wait at least 14 days after application before applying SINBAR.

Apply to actively growing quackgrass in the 3-5 leaf stage of growth.

### 2-4 Weeks After Planting (Postemergence Broadleaf Herbicides)

2,4-D *	0.55 kg/ha	
2,4-D (470g/L)	1.17 L/ha	0.47 L/acre

Use the amine formulation. Apply in 100 to 200 L/ha of water (40-80 L/ac). Use low pressure and a coarse spray to minimize risk of spray drift to susceptible crops. DO NOT use while early runners are rooting, or between mid-August and fall dormancy when flower buds are developing for next year's crop.

### 2-4 Weeks After Planting (Postemergence Grass and Broadleaf Herbicides)

glyphosate ROUNDUP TRANSORB (360g/L)	0.36 kg/2L 1 L/2L water	
GLYFOS (360g/L)	1 L/2L water	

Use a 33% solution in a rope wick or other wiper. Refer to section on "Selective Weed Control With Wiper Applicators". Avoid contact with strawberry plants.

glyphosate ROUNDUP TRANSORB (360g/L)	0.36 to 0.72 kg/100L 1 to 2 L/100L water	
GLYFOS (360g/L)	1 to 2 L/100L water	

Otherwise, a spot treatment with a 1-2% solution can be used, but crop in the treated area will be killed as well. DO NOT apply within 30 days before harvest.

### 4-6 Weeks After Planting (Soil Applied Grass and Broadleaf Herbicides)

terbacil SINBAR (80 WP)	0.22 to 0.44 kg/ha 0.28 to 0.55 kg/ha	0.11 to 0.22 kg/acre
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Apply in at least 300 L/ha water (120 L/ac) when mother plants are well established but before running becomes extensive and new runner plants are rooting. Apply preemergence or early postemergence to the weeds. Use lower rate on sandy soils low in organic matter and on sensitive varieties such as Earldawn, Midway, Micmac, Bounty and Kent, since they may be severely injured. This treatment may severely injure weak or diseased plants of any variety. Accurate calibration of sprayer is essential to avoid crop injury. DO NOT overlap spray swaths. Shallow cultivation can be done to train runners and control escaped weeds without destroying the effectiveness of terbacil.

### 4-6 Weeks After Planting (Postemergence Grass Herbicides)

fluzifop-p-butyl FUSILADE II (125g/L)	0.125 kg/ha 1 L/ha	0.4 L/acre
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Apply to actively growing annual grasses in the 2-5 leaf stage of growth. Use only one application per season. Wait at least 14 days after application before applying SINBAR.



fluzifop-p-butyl  
FUSILADE II (125g/L)

0.25 kg/ha  
2 L/ha

0.8 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth. Use only one application per season. Wait at least 14 days after application before applying SINBAR.

2,4-D \*

2,4-D (470g/L)  
0.55 kg/ha  
1.17 L/ha

0.47 L/ac

Use the amine formulation. Apply in 100 to 200 L/ha of water (40-80 L/ac). Use low pressure and a coarse spray to minimize risk of spray drift to susceptible crops. DO NOT use while early runners are rooting, or between mid-August and fall dormancy when flower buds are developing for next year's crop.

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)

0.36 kg/2L  
1 L/2L water  
1 L/2L water

Use a 33% solution in a rope wick or other wiper. Refer to section on "Selective Weed Control With Wiper Applicators". Avoid contact with strawberry plants.

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)

0.36 to 0.72 kg/100L  
1 to 2 L/100L water  
1 to 2 L/100L water

Otherwise, a spot treatment with a 1-2% solution can be used, but crop in the treated area will be killed as well. DO NOT apply within 30 days before harvest.

napropamide  
DEVIRINOL DF (50 DF)

4.5 kg/ha  
9 kg/ha

3.6 kg/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply to a weed free soil surface. DO NOT apply during harvest period. DO NOT apply more than once per season.

terbacil  
SINBAR (80 W/P)

0.144 to 0.22 kg/ha  
0.18 to 0.28 kg/ha

0.07 to 0.11 kg/ac

Apply in at least 300 L/ha water (120 L/ac), preemergence or early postemergence to the weeds. See remarks on terbacil above.

fluzifop-p-butyl  
FUSILADE II (125g/L)

0.125 kg/ha  
1 L/ha

0.4 L/ac

Apply to actively growing annual grasses in the 2-5 leaf stage of growth. Use only one application per season. Wait at least 14 days after application before applying SINBAR.

fluzifop-p-butyl  
FUSILADE II (125g/L)

0.25 kg/ha  
2 L/ha

0.8 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth.

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)

0.36 kg/2L  
1 L/2L water  
1 L/2L water

Use a 33% solution in a rope wick or other wiper. Refer to section on "Application Technology - Wiper Applicators". Avoid contact with strawberry plants.

glyphosate  
ROUNDUP TRANSORB  
(360g/L)  
GLYFOS (360g/L)

0.36 to 0.72 kg/100L  
1 to 2 L/100L water  
1 to 2 L/100L water

Spot treatments using this 1-2% solution will kill weeds and strawberry plants that are sprayed. Direct spray weeds only. DO NOT apply within 30 days before harvest.

napropamide  
DEVIRINOL DF (50 DF)

4.5 kg/ha  
9 kg/ha

3.6 kg/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply to a weed free soil surface just prior to mulching, but not on frozen ground. DO NOT apply more than once per season.

terbacil  
SINBAR (80 WP)

0.56 to 0.68 kg/ha  
0.7 to 0.85 kg/ha

0.28 to 0.34 kg/ac

Apply in at least 300 L/ha water (120 L/ac) just prior to mulching. Use low rate where it is planned to use terbacil again in the spring. See remarks on terbacil above.

### Strawberry - Harvesting Year

napropamide  
DEVIRINOL DF (50DF)

4.5 kg/ha  
9 kg/ha

3.6 kg/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply to a weed free soil surface just after mulch is removed, but not on frozen ground. DO NOT apply from bloom to harvest. DO NOT apply more than once per season.

terbacil  
SINBAR (80 WP)

0.22 to 0.28 kg/ha  
0.28 to 0.35 kg/ha

0.11 to 0.14 kg/ac

Apply in at least 300 L/ha water (120 L/ac) immediately after mulch is removed. If strawberry plants have made weak yellow growth under the mulch, wait 5-7 days until plants recover before applying terbacil. See remarks on terbacil above.

### Spring After Mulch Removal (Postemergence Grass and Broadleaf Herbicides)

fluzifop-p-butyl  
FUSILADE II (125g/L)

0.125 kg/ha  
1 L/ha

0.4 L/ac

Apply to actively growing annual grasses in the 2-5 leaf stage of growth. Use only one application per season. Apply before bloom. Preharvest interval is 30 days. Wait at least 14 days after application before applying SINBAR.

fluzifop-p-butyl  
FUSILADE II (125g/L)

0.25 kg/ha  
2 L/ha

0.8 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth. Use only one application per season. Apply before bloom. Preharvest interval is 30 days. Wait at least 14 days after application before applying SINBAR.

### Spring After Mulch Removal (Postemergent Grass and Broadleaf Herbicides)

glyphosate  
ROUNDUP TRANSORB  
(360g/L)

0.36 to 0.72 kg/100L  
1 to 2 L/100L water

Spot treatments using this 1-2% solution will kill weeds and strawberry plants that are sprayed. Direct spray weeds only. DO NOT apply within 30 days before harvest.

GLYFOS (360g/L)

1 to 2 L/100L water

glyphosate  
ROUNDUP TRANSORB  
(360g/L)

0.36 kg/2L  
1 L/2L water

Use a 33% solution in a rope wick or other wiper. Refer to section on "Application Technology - Wiper Applicators". Avoid contact with strawberry plants. DO NOT apply within 30 days before harvest.

GLYFOS (360g/L)

1 L/2L water

### Renovation (Soil Applied Grass and Broadleaf Herbicides)

terbacil  
SINBAR (80 WP)

0.56 to 0.68 kg/ha  
0.7 to 0.85 kg/ha

0.28 to 0.34 kg/ac

Apply in at least 300 L/ha water (120 L/ac) preemergence or early postemergence to the weeds. If, 2,4-D was used prior to mowing, delay applying terbacil for at least 2 weeks. See remarks on terbacil above. DO NOT apply within 14 days of FUSILADE II.

### Renovation (Postemergence Grass Herbicides)

fluazifop-p-butyl  
FUSILADE II (125g/L)

0.125 kg/ha  
1 L/ha

0.4 L/ac

Apply to actively growing annual grasses in the 2-5 leaf stage of growth. Use only one application per season. Some annual grasses such as foxtail may not be controlled with this application to regrowth. DO NOT use within 14 days of SINBAR.

fluazifop-p-butyl  
FUSILADE II (125g/L)

0.25 kg/ha  
2 L/ha

0.8 L/ac

Apply to actively growing quackgrass in the 3-5 leaf stage of growth. Use only one application per season. Some annual grasses such as foxtail may not be controlled with this application to regrowth. DO NOT use within 14 days of SINBAR.

### Renovation (Postemergent Broadleaf Herbicide)

2,4-D \*

1.034 kg/ha  
2.2 L/ha

0.88 L/ac

Use amine formulation. Apply after harvest but before mowing to control dandelions and other broadleaf perennials. Delay mowing for a few days after application. DO NOT apply 2,4-D between mid August and fall dormancy because of its possible effect on flower bud formation. Veestar is more sensitive to 2,4-D than Redcoat.

clopyralid

LONTREL 360 (360g/L)

0.2 to 0.3 kg/ha  
0.56 to 0.83 L/ha

0.22 to 0.33 L/ac

To control tufted vetch, Canada thistle, sheep sorrel and ox-eye daisy. Apply with a boom sprayer in 150 to 250 L/ha of water (60-100 L/ac). Apply once per year as a single treatment immediately after harvest at renovation, 7-10 days before mowing on new and established plantings. Early cultivars like Veestar or Annapolis may be more susceptible to injury. Certain environment stresses such as drought, flooding or severe overwintering conditions may increase the risk of injury. Pre-harvest interval is 200 days.

### Renovation (Postemergence Grass and Broadleaf Herbicide)

glyphosate

ROUNDUP TRANSORB  
(360g/L)

0.36 kg/2L  
1 L/2L water

0.36 kg/ac

Use a 33% solution in a rope wick or other wiper. Refer to section on "Application Technology - Wiper Applicators". Avoid contact with strawberry plants.

GLYFOS (360g/L)

1 L/2L water

1 L/2L water

glyphosate

ROUNDUP TRANSORB  
(360g/L)

0.36 to 0.72 kg/100L  
1 to 2 L/100L water

0.36 kg/ac

Spot treatment using this 1-2% solution will kill weeds and strawberry plants in treated area. Direct spray to weeds only. DO NOT apply within 30 days before harvest.

GLYFOS (360g/L)

1 to 2 L/100L water

1 L/2L water

### Late Summer/Fall (Labour Day) (Self Applied Grass & Broadleaf Herbicide)

napropamide

DEVIRINOL DF (50 DF)

4.5 kg/ha  
9 kg/ha

3.6 kg/ac

Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply to a weed free soil surface. DO NOT apply during harvest period. DO NOT apply more than once per season.

terbacil

SINBAR (80 WP)

0.144 to 0.22 kg/ha  
0.18 to 0.28 kg/ha

0.07 to 0.11 kg/ac

Apply in at least 300 L/ha water (120 L/ac), preemergence or early postemergence to the weeds. See remarks on terbacil above.

### Late Summer/Fall (Labour Day) (Post-harvest Broadleaf Herbicide)

fluazifop-p-butyl

FUSILADE II (125g/L)

0.125 kg/ha  
1 L/ha

0.4 L/ac

Apply to actively growing annual grasses in the 2-5 leaf stage of growth. Use only one application per season. Wait at least 14 days after application before applying SINBAR.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT PER HA	RATE PRODUCT PER ACRE	
fluazifop-p-butyl FUSILADE II (125g/L)	0.25 kg/ha 2 L/ha	0.8 L/ac	Apply to actively growing quackgrass in the 3-5 leaf stage of growth. Use only one application per season. Wait at least 14 days after application before applying SINBAR.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L)	0.36 kg/2L 1 L/2L water 1 L/2L water		Use a 33% solution in a rope wick or other wiper. Refer to section on "Application Technology - Wiper Applicators". Avoid contact with strawberry plants.
glyphosate ROUNDUP TRANSORB (360g/L) GLYFOS (360g/L)	0.36 to 0.72 kg/100L 1 to 2 L/100L water 1 to 2 L/100L water		Spot treatments using this 1-2% solution will kill weeds and strawberry plants that are sprayed. Direct spray weeds only. DO NOT apply within 30 days before harvest.
<b>Late Fall (Soil Applied Grass and Broadleaf Herbicides)</b>			
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	Incorporation by rainfall or irrigation is essential - see "Notes on Chemicals" section. Apply to a weed free soil surface just prior to mulching, but not on frozen ground. DO NOT apply more than once per season.
terbacil SINBAR (80 WP)	0.56 to 0.68 kg/ha 0.7 to 0.85 kg/ha	0.28 to 0.34 kg/ac	Apply in at least 300 L/ha water (120 L/ac) just prior to mulching. Use low rate where it is planned to use terbacil again in the spring. See remarks on terbacil above.







TABLE 12-5. Fruit Crop Herbicide Weed Control Ratings

	apples	apricots	blackberries	cherries/plums	currants/gooseberries	grapes	highbush blueberries	peaches	pears	raspberries	barley grass	crabgrass	fall panicum	foxtail	old witch grass	sandbar	chickweed, common	lady's thumb	lamb's-quarters	mustards	pigweeds	ragweed	bindweed, field	chickweed, mouse-eared	dandelion	goldenrod	grape, wild	ground-ivy (creeping-charlie)	mallow	milkweed	nightsade, climbing	nurt sedge	plantains	poison ivy	quackgrass	sow-thistle	stinging nettle	thistle, Canada	velvet	virginia creeper			
fluazifop-p-butyl	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
sethoxydim	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	8	8	8	8	8	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
basagran	✓ <sup>2</sup>	✓ <sup>2</sup>	✓ <sup>2</sup>	✓ <sup>13</sup>	✓	✓	✓ <sup>2</sup>	✓ <sup>2</sup>	✓ <sup>2</sup>	✓ <sup>2</sup>	0	0	0	0	0	0	8	9	9	8	8	8	7	7	7	7	7	7	7	7	7	5	2	8	2	7	2	5	8 <sup>5</sup>	6	5	7	
lontrel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	0	0	0	0	0	0	7	5	7	5	9	0	0	8	7	7	7	7	7	7	0	0	7	0	0	0	8	7	9	8	7	
2,4-D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	0	0	0	0	?	7	6	8	9	8	5	2	8	2	8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
amitrol-T	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	7	7	8	7	7	?	7	6	6	7	5	7	?	?	?	?	?	?	?	?	?	8	7	8	7	8	8	8	8	8	8	8	
ignite	✓	✓ <sup>3</sup>	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	8	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8		
glyphosate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	9	9	9	8	9	8	8	8	8	8	8	8	5	9	7	5	9	9	9	5	9	5	8	
touchdown	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
gramoxone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
gramoxone + devrinol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	

\* Various formulations available, see Table 13-1.

? Insufficient information available to make a rating

✓ Indicates crop registration

<sup>1</sup> For Cherries only<sup>2</sup> Non-bearing trees only<sup>3</sup> For Plums only<sup>a</sup> top growth only; regrowth can be expected<sup>b</sup> use higher rates when larger than 15 cm tall or across

# Notes:

Weed control ratings are given as 0-9 where 0 indicates no control and 9 indicates 90%-100% control under ideal conditions. Ratings are subjective values based on best available information and give general comparisons based on use as described in this guide. Under unfavorable conditions (eg., too dry, too wet, too cold, or poor application) the herbicides may not be as effective as indicated. Ratings may vary with weed and crop stage and with the timing and rates of the product(s) being used. Ratings in **BOLD** suggest the weed is listed on the product label for control or suppression. Please see product label for more information on registered weed species, product uses and precautions.

**TABLE 12-6. Strawberry Herbicide Weed Control Ratings**

Treatment	Trade Name	Annual Grasses										Annual Broadleaves										Perennial Weeds															
		barnyard grass	crabgrass	tall panicum	foxtails	old witch grass	volunteer grains	chickweed, common	groundsel	lady's thumb	lamb's-quarters	mustards	pigweeds	ragweed	snapdragon, dwarf	violet, field (field pansy)	bindweeds	brome grass	chickweed, mouse-eared	daisy, ox-eye	dandelion	ground-ivy (creeping-charlie)	mallow	milkweed	nut sedge	plantains	poison ivy	quackgrass	sorel, sheep	sow-thistle	thistle, Canada	toadflax, yellow	velches				
w/ applied grass and broadleaf herbicides																																					
trifluralin	BONANZA, TREFLAN, RIVAL	8	9	8	9	8	9	8	3	7	8	3	8	4	?	?	0	?	5	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0			
napropamide	DEVIRINOL	8	9	8	8	8	8	8	6	8	5	8	6	0	0	0	8	8	?	?	2	?	?	?	5	5	2	?	5	0	5	5	?	0			
terbacil	SINBAR	8	7	8	8	8	8	8 <sup>a</sup>	5	7 <sup>a</sup>	8 <sup>a</sup>	8 <sup>a</sup>	7 <sup>a</sup>	2	5 <sup>a</sup>	?	?	8	?	2	5	?	?	?	6	6	8	?	6	8	5	6	2	2			
post-emergence grass herbicides																																					
fluzifop-p-butyl	FUSILADE II	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0				
post-emergence broadleaf herbicides																																					
2,4-D	2,4-D*	0	0	0	0	0	0	7	2	6	8	9	7	8	2	2	2	0	2	2	8	2	0	0	0	0	8	?	0	8	6	8	?	5			
clopyralid	LONTREL 360	0	0	0	0	0	0	0	8	?	5	?	5	9	?	?	0	0	0	8	8	0	0	0	0	0	0	0	0	9	8 <sup>b</sup>	9	0	9			
post-emergence grass and broadleaf herbicides																																					
	GRAMOXONE	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>a</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>	8 <sup>b</sup>				
glyphosate	GLYFOS, ROUNDUP, TOUCHDOWN <sup>1</sup>	9	9	9	9	9	9	9	8	9	8	9	9	8	?	?	7/8	9	9	?	8	5	5	9	8	9	9	9	8	8	9	9	8	5 <sup>a</sup>			

\* Various products are available, see Table 13-1.

? Insufficient information available to make a rating

<sup>1</sup> After harvest spot treatment only

<sup>a</sup> Low rates and single applications may provide less control.

<sup>b</sup> Top growth only; regrowth can be expected. Repeated treatments may provide control.

## Water Weeds (Aquatic Plants)

A Permit to Purchase and/or Perform a Water Extermination must be obtained before a pesticide, for control of aquatic weeds, can be legally purchased and/or applied to surface waters in Ontario (unless exempt).

An exemption from the permit requirement is made for "agriculturists" who wish to treat a water body wholly confined within their property and where there is no outflow, at any time, beyond their property limits.

For further information on licensing and permits, contact any Ontario Ministry of the Environment Regional Office.

Herbicides provide temporary control of nuisance aquatic vegetation. Alternate methods such as mechanical removal (Submergents), dredging or substrate alteration (drainage ditches) can provide longer term control. Management techniques for vegetation control in ponds include minimizing nutrient input, dredging excess sediment, logs and other organic debris, decreasing the surface to depth ratio and increasing the rate of pond turnover (flushing). Some aquatic plant and algae life should be accepted and tolerated as a vital component of a healthy ecosystem.

The use of herbicides may be complicated by the use of water by livestock or humans or by the presence of fish. If the water is flowing, the effect of the chemical on plant, animal, or fish life downstream must be considered. Flowing water, by diluting the herbicide, makes control less effective.

The vegetation also varies widely; species include completely submerged ones such as Elodea (Elodea, Canada waterweed) and algae; free floating ones such as water lilies and emergent plants. Many emergents will grow equally as well on the moist shoreline as when their lower stems and roots are in water. Where these emergent species have taken possession of the shoreline, control measures must embrace that area as well as the water.

Chara (Chara stonewort, muskgrass) are a gray green to green plant-like algae, attached to the sediment, or free floating which in dense communities has a very strong musk odour. It is brittle to the touch and will dry to a white powder upon removal from the water. This plant is difficult to control with moderate doses of algacides and dense communities should be removed mechanically.

Tapegrass (wild celery) (Vallisneria spiralis); found in many recreational lakes, is resistant to all the currently recommended herbicides. It has long rubbery leaves and numerous short roots. Control is possible only by mechanical methods such as pulling.

Diquat (REGLONE A) provides good control of a wide variety of submergent species including water-milfoil, pondweeds Elodea (Elodea Canada waterweed) and coontail. This herbicide is not effective against chara stonewort muskgrass (Chara spp). Diquat should be applied on cloudy days in late afternoon and care should be taken not to stir up the bottom since turbidity reduces the effectiveness of treatment. Since diquat takes effect rapidly, decomposition of a large plant mass may deplete oxygen levels which can cause fish to suffocate. Thus, in ponds where fish are present and growth is well established, no more than 1/4 to 1/2 of the pond should be treated at one time. Wait two weeks before treating again. The best time to apply these chemicals is late spring while the plants are growing rapidly. Since this is a contact chemical, control is achieved for one season, and repeat treatments must be made annually.

Emergent species such as cattails and bulrushes may have to be sprayed for 2 or 3 consecutive years to bring them under complete control. The chemicals for cattails and other emergents are sprayed so as to thoroughly wet all exposed foliage. Paraquat and amitrole are most effective when cattails are coming into head. Consult the manufacturer's directions.

Use of copper based algacides may be toxic to trout or other fish. To avoid suffocation of fish due to oxygen depletion from decaying vegetation treat ponds in sections and observe recommended time periods between partial treatments. Copper algacides may be used only in ponds where water is wholly confined within the property of the user and where there is no outflow beyond the property limits at any time.

copper ethanolanine	0.17 kg/1000m <sup>3</sup>	Filamentous algae, pond scums. Use only in water where there is no discharge from the property.
CUTRINE PLUS (9 Li)	1.89 L/1000m <sup>3</sup>	Not for use in potable waters. No restrictions on fishing or swimming. Care should be taken if fish are present. When algae are dense make 3 partial treatments; observe 7-14 day waiting period between treatments. Dilute the product 1 to 9 with water before applying. Fish caution: CUTRINE PLUS is toxic to fish - extremely toxic in water of low hardness. Where water hardness is unknown do not use if fish are present.
	0.5 m - use 9.21 L/ha	
	1 m - use 18.42 L/ha	
	1.5 m - use 27.63 L/ha	

copper ethanolamine  
CUTRINE PLUS (9 Li)

0.32 kg/1000m<sup>3</sup>  
0.5 m - use 18.42  
L/ha  
1 m - use 36.84 L/ha  
1.5 m - use 55.26  
L/ha

0.5 m - use 7.37  
L/ac  
1 m - use 14.74 L/ac  
1.5 m - use 22.1  
L/ac

Chara and Nitella spp. in ponds. For use in ponds wholly confined within the user's property and where there is no outflow beyond the property limits at any time. In hard water CUTRINE PLUS is toxic to fish if 0.4 ppm is exceeded. If fish are present but water hardness is not known, do not use CUTRINE PLUS. Split treatments at 7-14 day intervals are recommended to avoid oxygen depletion where plant mass is dense. Dilute product 1 to 9 with water before applying. Also see CAUTION at start of section.

diquat(aquatic)

REGLONE A (200g/L)

4.4 to 7 kg/ha  
22 to 35 L/ha

8.8 to 14 L/ac

Mixed submerged vascular plants in ponds, ditches, lakes, river canals, slow moving or still water. DO NOT use treated water for animal consumption or swimming for at least 24 hours. DO NOT use for human consumption or irrigation for at least 5 days. To avoid oxygen depletion, treat only 1/4 to 1/3 of the area at a time. Apply at dusk in mid to late June when plants are young and growing vigorously. Tape grass and Chara are NOT controlled.

diquat(aquatic)

REGLONE A (200g/L)

2.2 kg/ha  
11 L/ha

4.4 L/ac

Eurasian water milfoil in lakes. Treat when plants are in the very early stage of growth (June). See diquat note above.

water soluble dyes

AQUASHADE (26 Li)

195 mL/1000m<sup>3</sup>  
750 mL/1000m<sup>3</sup>

4.4 L/ac

Filamentous algae, pond scums. For use in ponds with no outflow. DO NOT apply to water that will be used for drinking or other domestic purposes. Make application early in the growing season before algae and weed growth develop. Re-apply when the colour of water fades or first new algae growth develops. Mechanically remove any heavy vegetation before applying AQUASHADE to avoid oxygen depletion and fish suffocation.

amitrole

AMITROL 240 (231g/L)

9 to 11 kg/ha  
37.5 to 45.75 L/ha

15 to 18.3 L/ac

Cattails in non crop areas (roadsides, fencerows, ditch banks, drainage ditches). Apply after catkins are fully formed and up to frost. DO NOT disturb sprayed plant. DO NOT apply where water will be used for irrigation, drinking or other domestic uses. DO NOT apply where water is not wholly confined to users property. Apply at a spray volume of 1000 L/ha (400 L/ac) water.

diquat(aquatic)

REGLONE A (200g/L)

2.2 to 6.4 kg/ha  
11 to 32 L/ha

4.4 to 12.8 L/ac

Duckweed. Apply by directed surface spray on foliage. Use in 1700-2200 L/ha (680-880 L/ac) water. See REMARKS on previous page.

paraquat

GRAMOXONE (200g/L)

1.1 to 2.2 kg/ha  
5.5 to 11 L/ha

2.2 to 4.4 L/ac

Cattails, bulrushes and emerged grasses. DO NOT use treated water for 7 days for swimming, human or animal consumption. DO NOT use for irrigation for 5 days. DO NOT apply to muddy water or agitate water excessively for 1-2 days after treatment. Treat cattails and bulrushes when plants are in flower. Avoid inhalation of spray mist; consult label for appropriate protective clothing. Apply at a spray volume of 850-1000 L/ha (340-400 L/ac) water.



TABLE 12-7 Habitats and Herbicide Susceptibility of Common Aquatic Plants

	spring-fed pond	dugout	soft water lake*	hard water lake**	wet ditch***	dry ditch****	Mechanical Control	Copper compound (1)	Diquat (2)	Paraquat (3)	Amitrole (4)
<i>Spirogyra</i> spp.	VC	VC	C-I		VC	I		S	R		
<i>Ulothrix</i> spp.	C	VC			VC			S	R		
<i>Mougeotia</i> spp.	C	VC			VC			S	R		
<i>Cladophora</i> spp.	VC	VC	C	VC	VC	VC		S	R		
<i>Chara</i> spp. (Muskgrass)	VC	I	C-I	VC-I	VC	R		S	R		
<i>Nitella</i> spp. (Stonewort)	I	R	VC	R	R	R		S	R		
<i>Sago pondweed</i> ( <i>P. pectinatus</i> )	I	C-I		VC				R	S		
<i>Curly-leaf pondweed</i> ( <i>P. crispus</i> )	C	VC		VC				R	S		
<i>Baseweed</i> ( <i>P. amplifolius</i> )	R	C		C				R	I		
<i>Richardson pondweed</i> ( <i>P. richardsonii</i> )				VC-C				R	S-I		
<i>Flat-stemmed pondweed</i> ( <i>P. zosterifolius</i> )				C				R	S		
other narrow-leaf pondweed ( <i>Potamogeton</i> spp.)	I	C	C	VC-C				R	S		
<i>Eurasian water milfoil</i> ( <i>Myriophyllum spicatum</i> )	C		VC	VC				R	VS		
<i>Native milfoil</i> ( <i>M. exalbescens</i> and others)		C	C	VC				R	S-I		
<i>Blackdenwort</i> ( <i>Utricularia vulgaris</i> )		C		VC				R	I		
<i>Coontail</i> ( <i>Ceratophyllum demersum</i> )		C		C				R	S-I		
<i>Water stargrass</i> ( <i>Heteranthera dubia</i> )				C				R			
<i>Tape grass</i> ( <i>Vallisneria spiralis</i> )	R	I	C	VC	R	R	M**	R	R	R	R
<i>Water naiad</i> ( <i>Najas flexilis</i> )		I		VC				R	S		
<i>Canada water weed</i> ( <i>Elodea canadensis</i> )		C		VC				R	I		
<i>Cattails</i> ( <i>T. latifolia</i> , <i>T. angustifolia</i> )	VC	VC		VC	VC	I-C	M	R	R	I	S-I
<i>Bulrush</i> ( <i>Scirpus</i> spp.)			C	VC	C	C	M	R			S-I
<i>Sedge</i> ( <i>Carex</i> spp.-A42)	C		C	C	C	VC	M	R			S-I
<i>Bur reed</i> ( <i>Sparganium</i> spp.)			C	C	C	VC	M	R			I
<i>Water plantain</i> ( <i>Alisma</i> spp.)			I	C	C	VC		R			S
<i>Pipewort</i> ( <i>Eracaulon</i> spp.)	R	R	C	R	R	R	M*	R		S	
<i>Arrowhead</i> ( <i>Sagittaria</i> spp.)		C		VC	I-C			R		S	
<i>Pickersweed</i> ( <i>Pontederia</i> spp.)			VC		I	R		R		S-I	
<i>Water smartweed</i> ( <i>Polygonum amphibium</i> )	I	I						R		S-I	
<i>Water shield</i> ( <i>Brasenia</i> spp.)			C	C			M*	R		I	
<i>White water lily</i> ( <i>Nymphaea</i> spp.)			C	C			M*	R		I	
<i>Yellow water lily</i> ( <i>Nuphar</i> spp.)		C-I	C	C				R		S	
<i>Duckweed</i> ( <i>Lemna</i> spp.)	R	C	I-R	VC				R	S	S	
<i>Duckmeal</i> ( <i>Wolffia</i> spp.)	R	C-I	I-R	VC				R	S	S	

VC - very common, C - common, I - infrequent, R - rare, S - susceptible, I - intermediate, R - resistant  
M - manual or mechanical methods equally as effective as herbicides M\* - manual or mechanical methods are generally more effective than herbicides

M\*\* - manual or mechanical methods are the only control measure currently available  
M\*\*\* - manual or mechanical methods are the only control measure currently available

\* A typical Muskoka lake is an example of a soft water lake \*\* A typical Kawartha lake is an example of a hard water lake

\*\*\* A wet ditch contains water at time of treatment \*\*\*\* A dry ditch contains no water at time of treatment

1 - Copper compound (Citrine Plus) 2 - Diquat (Reglone A) 3 - Paraquat (Gramoxone) 4 - Amitrole (Amitrole 240)



# 13. Pesticide Tables

TABLE 13-1. Pesticides Used on Fruit Crops in Ontario

Common, Brand & Trade Names* (see end note)	Example of Brand Name* Products or Common or other name of active	Use**	Formulation***	Guaranteed% active unless stated	Ont.Sch. (Table 13-2)	Winter Storage (see end note)	Man./Agent's Code
2,4-D	2,4-D	h	Sn	470 g/L	3	A	INT
2,4-D	ESTEMINE 2,4-D	h	Sn	470 g/L	3	A	UAG
2,4-D	2,4-D AMINE 600	h	Sn	560 g/L	3	A	INT
abamectin	AGRI-MEK	ai	EC	18 g/L	3		NVT
ADMIRE	imidacloprid	i	FI	240 g/L	5		BBB
AFOLAN F	linuron	h	Su	480 g/L	3	A	ARV
AGRI-MEK	abamectin	ai	EC	18 g/L	3		NVT
ALIETTE	fosetyl al	f	WG	80	5		RHQ
amitraz	MITAC	i	WP	50	2		ARV
AMITROL-T	amitrole	h	Sn	200 g/L	3	A <sup>2</sup>	NUF
amitrole	AMITROL-T	h	Sn	200 g/L	3	A <sup>2</sup>	NUF
ammonium salts of higher fatty acids	HINDER	x	Li	15	6		UNR
APM	azinphos methyl	i	WP	50	5		NRA
APOLLO	clofentezine	ai	SC	500 g/L	2		ARV
azinphos methyl	APM	i	WP	50	5		NRA
azinphos methyl	GUTHION	i	WP	50	5		BBB
azinphos methyl	SNIPER	i	WP	50	5		UAG
AQUASHADE	water soluble dyes		Li	26	2	A	APB
bacillus thuringiensis	DIPEL	i	WP	16,000/mg	3		ABT
bacillus thuringiensis	FORAY	i	Li	10,600/mg	3		ABT
BASAGRAN	bentazon	h	Sn	480 g/L	3	B	BAZ
BENLATE	benomyl	f	WP	50	3		DUQ
benomyl	BENLATE	f	WP	50	3		DUQ
bentazon	BASAGRAN	h	Sn	480 g/L	3	B	BAZ
BONANZA 400	trifluralin	h	EC	400 g/L	3	B	UAG
BOTRAN	dichloran	f	WP	75	3		GOW
BRAVO	chlorothalonil	f	FI	500 g/L	3		NVT
CAPTAN	captan	f	WP	50	3		TOA,MKC
captan	CAPTAN	f	WP	50	3		TOA,MKC

TABLE 13-1. Pesticides Used on Fruit Crops in Ontario (cont'd)

Common, Brand & Trade Names* (see end note)	Example of Brand Name* Products or Common or other name of active	Use**	Formulation***	Guaranteed% active unless stated	Ont.Sch. (Table 13-2)	Winter Storage (see end note)	Man/Agent's Code
captan	MAESTRO	f	DF	75	2		TOA
carbaryl	SEVIN XLR PLUS	i	Su	480 g/L	3		RHQ
carbofuran	FURADAN	i	FI	480 g/L	5		BBB
CARZOL	formetanate hydrochloride	a	SP	92	5		ARV
CASORON 4G	dichlobenil	h	Gr	4	3	C	UNR
chlorophacinone	ROZOL	r	pellet	0.005	3,6		UAG,LPH
chlorothalonil	BRAVO	f	FI	500 g/L	3		NVT
chlorpyrifos	LORSBAN	i	WP	50	2		DWE
clofentezine	APOLLO	a	Sc	500 g/L	2		ARV
clopyralid	LONTREL 360	h	Sn	360 g/L	2	A	DWE
CONFIRM	tebufenozide	i	FI	240 g/L	2		ROH
COPPER 53	tri-basic copper sulphate	b	WP	53	2		UAG
copper ethanolamine	CUTRINE PLUS	h	Sn	9	2	A	APB
copper ethanolamine	CUTRINE PLUS	h	Gr	3.7	2	B	APB
CUTRINE PLUS	copper ethanolamine	h	Sn	9	2	A	APB
CUTRINE PLUS	copper ethanolamine	h	Gr	3.7	2	B	APB
CYGON	dimethoate	i	EC	480 g/L	2		CNV
cyhalothrin lambda	MATADOR	i	EC	120 g/L	2		ZNA
CYMBUSH	cypermethrin	i	EC	250 g/L	2		ZNA
cypermethrin	CYMBUSH	i	EC	250 g/L	2		ZNA
cypermethrin	RIPCORD	i	EC	400 g/L	2		CYC
cyprodinil	VANGARD	f	WG	75	3		NVT
DECIS	deltamethrin	i	EC	50 g/L	2		ARV
deltamethrin	DECIS	i	EC	50 g/L	2		ARV
DEVRIOL 50W	napropamide	h	WP	50	3	C	UAG
DEVRIOL DF	napropamide	h	DF	50	3	C	UAG
DIAZINON	diazinon	i	WP	50	2		UAG
diazinon	DIAZINON	i	WP	50	2		UAG
dichlobenil	CASORON 4G	h	Gr	4	3	C	UNR
dichloran	BOTRAN	f	WP	75	3		GOW
dicofol	KELTHANE	a	WP	50	2		ROH
DIKAR	no common name	af	WP	72	3		ROH
dimethoate	CYGON	i	EC	480 g/L	2		CNV
DIPEL	bacillus thuringiensis	i	WP	16,000/mg	3		ABT
diphacinone	RAMIK BROWN	r	pellets	0.005	6		HOK
diquat(aquatic)	REGLONE A	h	Li	200 g/L	2	A	ZNA
DITHANE	mancozeb	f	DG	75	3		ROH
diuron	KARMEX	h	DF	80	2	C	GRN
dodine	EQUAL	f	WP	65	3		NRA
DUAL MAGNUM	metolachlor	h	EC	915 g/L	2	B	NVT
ELEVATE	fenhexamid	f	WDG	50	3		TOA
ENDOSULFAN	endosulfan	i	WP	50	2		UAG
endosulfan	ENDOSULFAN	i	WP	50	2		UAG

TABLE 13-1. Pesticides Used on Fruit Crops in Ontario (cont'd)

Common, Brand & Trade Names* (see end note)	Example of Brand Name* Products or Common or other name of active	Use**	Formulation***	Guaranteed% active unless stated	Ont.Sch. (Table 13-2)	Winter Storage (see end note)	Man./Agent's Code
endosulfan	THIODAN	i	WP	50	2		ARV
EQUAL	dodine	f	WP	65	3		NRA
ESTEMINE 2,4-D	2,4-D	h	Sn	470 g/L	3	A	UAG
fenhexamid	ELEVATE	f	WDG	50	3		TOA
FERBAM	ferbam	f	WG	76	3		UAG
ferbam	FERBAM	f	WG	76	3		UAG
fluazifop-p-butyl	FUSILADE II	h	EC	125 g/L	5	C	ZNA
flusilazole	NUSTAR	f	DF	20	3		UAG
FOLPAN	folpet	f	WP	50	2,3		UAG,ZNA, MKC
folpet	FOLPAN	f	WP	50	2,3		UAG,ZNA, MKC
FORAY BA	Bacillus thuringiensis	i	Li	10,600/mg	3		ABT
formetanate hydrochloride	CARZOL	a	SP	92	5		ARV
fosetyl al	ALIETTE	f	WG	80	5		RHQ
FUNGINEX	triforine	f	EC	190 g/L	6		CYC
FURADAN	carbofuran	i	FI	480 g/L	5		BBB
FUSILADE II	fluazifop-p-butyl	h	EC	125 g/L	5	C	ZNA
glufosinate ammonium	IGNITE	h	Sn	150 g/L	3	A	ARV
glyphosate	LAREDO	h	Sn	356 g/L	3	B	MOL
glyphosate	RENEGADE	h	Sn	356 g/L	3	B	MOL
glyphosate	ROUNDUP	h	Sn	356 g/L	3	B	MOL
glyphosate	WRANGLER	h	Sn	356 g/L	3	B	MOL
glyphosate TMS	TOUCHDOWN 480	h	Sn	330 g/L	6	B	ZNA
GRAMOXONE	paraquat	h	Sn	200 g/L	2	A	ZNA
GUTHION	azinphos methyl	i	WP	50	5		BBB
HINDER	ammonium salts of higher fatty acids	x	Li	15	6		UNR
IGNITE	glufosinate ammonium	h	Sn	150 g/L	3	A	ARV
imidacloprid	ADMIRE	i	FI	240 g/L	5		BBB
IMIDAN	phosmet	i	WP	50	3		GOW
iprodione	ROVRAL	f	WP	50	3		RHQ
KARMEX	diuron	h	DF	80	2	C	GRN
KELTHANE	dicofol	a	WP	50	2		ROH
KERB	propyzamide	h	WP	50	3	C	ROH
KUMULUS	sulphur	f	DF	80	6		BAZ
LANNATE T-N-G	methomyl	i	SC	215 g/L	2		DUQ
LAREDO	glyphosate	h	Sn	356 g/L	3	B	MOL
LEXONE DF	metribuzin	h	DF	75	2	C	DUQ
linuron	AFOLAN F	h	Su	480 g/L	3	A	ARV
linuron	LINURON 480	h	Su	480 g/L	3	A	UAG
linuron	LOROX DF	h	DF	50	3	C	GRN
linuron	LOROX L	h	Su	480 g/L	3	A	GRN
LINURON 480	linuron	h	Su	480 g/L	3	A	UAG
LONTREL 360	clopyralid	h	Sn	360 g/L	2	A	DWE
LOROX DF	linuron	h	DF	50	3	C	GRN

TABLE 13-1. Pesticides Used on Fruit Crops in Ontario (cont'd)

Common, Brand & Trade Names* (see end note)	Example of Brand Name* Products or Common or other name of active	Use**	Formu- lation ***	Guaranteed% active unless stated	Ont.Sch. (Table 13-2)	Winter Storage (see end note)	Man/ Agent's Code
LOROX L	linuron	h	Su	480 g/L	3	A	GRN
LORSBAN	chlorpyrifos	i	WP	50	2		DWE
MAESTRO	captan	f	DF	75	2		TOA
MALATHION	malathion	i	WP	25	3		WBR
malathion	MALATHION	i	WP	25	3		WBR
mancozeb	DITHANE	f	DG	75	3		ROH
mancozeb	MANZATE 200	f	WP	80	3		GRN
mancozeb	PENNCOZEB	f	DF	75	3		EFA
MANZATE 200	mancozeb	f	WP	80	3		GRN
MATADOR	cyhalothrin lambda	i	EC	120 g/L	2		ZNA
MCPB/MCPA	TROPOTOX PLUS	h	Sn	400 g/L	3	A	RHQ
metalaxyl + copper hydroxide	RIDOMIL/COPPER	f	WP	70	2		NVT
metalaxyl-M	RIDOMIL GOLD	f	EC	480 g/L	2		NVT
metalaxyl + mancozeb	RIDOMIL GOLD MZ	f	WP	68	2		NVT
metam sodium	VAPAM	bthin	Sn	380 g/L	3	C	AMV
methidathion	SUPRACIDE	i	EC	240 g/L	2		NVT
methomyl	LANNATE T-N-G	i	SC	215 g/L	2		DUQ
methyl bromide/ chloropicrin	TERR-O-GAS 67	bthin		67 + 31	1		GLC
methyl isothiocyanate/ dichloropropene	VORLEX PLUS	bthin		203g + 373g/L	2	B	ARV
methyl isothiocyanate/ dichloropropene/ chloropicrin	VORLEX PLUS CP	bthin		185 g + 370 g + 163 g/L	2	B	ARV
metiram	POLYRAM	f	DF	80	3		BAZ
metolachlor	DUAL MAGNUM	h	EC	915 g/L	2	B	NVT
metribuzin	LEXONE DF	h	DF	75	2	C	DUQ
metribuzin	LEXONE DF TOSS'N GO	h	DF	75	2	C <sup>3</sup>	DUQ
metribuzin	SENCOR 75 DF	h	WG	75	2	C	BBB
metribuzin	SENCOR SOLUPAK	h	WG	75	2	C	BBB
mineral oil	SUPERIOR OIL	ai	Li	98.5	6		BAT
MITAC	amitraz	i	WP	50	5		ARV
myclobutanil	NOVA	f	WP	40	2		ROH
napropamide	DEVRIINOL 50W	h	WP	50	3	C	UAG
napropamide	DEVRIINOL DF	h	DF	50	3	C	UAG
NOVA	myclobutanil	f	WP	40	2		ROH
NUSTAR	flusilazole	f	DF	20	3		DUQ
oxamyl	VYDATE	i	Li	240 g/L	5		DUQ
paraquat	GRAMOXONE	h	Sn	200 g/L	2	A	ZNA
PARATHION	parathion	i	WP	15	5		UAG
parathion	PARATHION	i	WP	15	5		UAG
PENNCOZEB	mancozeb	f	DF	75	3		EFA
permethrin	POUNCE	i	EC	384 g/L	3		UAG,BBB
phosalone	ZOLONE	i	FI	500 g/L	2		RHQ

TABLE 13-1. Pesticides Used on Fruit Crops in Ontario (cont'd)

Common, Brand & Trade Names* (see end note)	Example of Brand Name* Products or Common or other name of active	Use**	Formulation***	Guaranteed% active unless stated	Ont. Sch. (Table 13-2)	Winter Storage (see end note)	Man./Agent's Code
phosmet	IMIDAN	i	WP	50	3		GOW
pirimicarb	PIRIMOR	i	DF	50	2		ZNA
PIRIMOR	pirimicarb	i	DF	50	2		ZNA
POAST	sethoxydim	h	EC	184 g/L	3	B <sup>1</sup>	BAZ
POLYRAM	metiram	f	DF	80	3		BAZ
POUNCE	permethrin	i	EC	384 g/L	3		UAG,BBB
PRINCEP NINE-T	simazine	h	WG	90	2	C	NVT
propiconazole	TOPAS	f	EC	250 g/L	2		ENG
propyzamide	KERB	h	WP	50	3	C	RHQ
PYRAMITE	pyridaben	a	WP	75	2		BAZ
pyridaben	PYRAMITE	a	WP	75	2		BAZ
RAMIK BROWN	diphacinone	r	pellets	0.005	6		UAG,HOK
REGLONE A	diquat(aquatic)	h	Li	200 g/L	2	A	ZNA
RENEGADE	glyphosate	h	Sn	356 g/L	3	B	MOL
RIDOMIL GOLD	metalaxyl-M	f	EC	480 g/L	2		NVT
RIDOMIL GOLD MZ	metalaxyl+ mancozeb	f	WP	68	2		NVT
RIDOMIL/COPPER	metalaxyl + copper hydroxide	f	WP	70	2		NVT
RIPCORD	cypermethrin	i	EC	400 g/L	2		CYC
RIVAL	trifluralin	h	EC	500 g/L	3	A	ARV
RIVAL DF	trifluralin	h	DF	60	2	C	ARV
RONILAN	vinclozolin	f	DF	50	2		BAZ
ROUNDUP	glyphosate	h	Sn	356 g/L	3	B	MOL
ROVRAL	iprodione	f	WP	50	3		RHQ
ROZOL	chlorophacinone	r	pellets	0.005	3,6		UAG,LPH
SENATOR	thiophanate-methyl	f	WP	70	2		ENG
SENCOR 75 DF	metribuzin	h	WG	75	2	C	BBB
SENCOR SOLUPAK	metribuzin	h	WG	75	2	C	BBB
sethoxydim	POAST	h	EC	184 g/L	3	B <sup>1</sup>	BAZ
SEVIN XLR PLUS	carbaryl	i	Su	480 g/L	3		RHQ
SIMADEx	simazine	h	Su	500 g/L	2	A	ARV
simazine	PRINCEP NINE-T	h	WG	90	2	C	NVT
simazine	SIMADEx	h	Su	500 g/L	2	A	ARV
simazine	SIMAZINE 480	h	Su	480 g/L	2	A	UAG
simazine	SIMAZINE 80W	h	WP	80	2	C	UAG
SIMAZINE 480	simazine	h	Su	480 g/L	2	A	UAG
SIMAZINE 80W	simazine	h	WP	80	2	C	UAG
SINBAR	terbacil	h	WP	80	2	C	DUQ
SNIPER	azinphos methyl	i	WP	50	5		UAG
STREPTOMYCIN 17	streptomycin sulphate	b	WP	17	3		UAG
streptomycin sulphate	STREPTOMYCIN 17	b	WP	17	3		UAG
sulphur	KUMULUS, various	f	DF	80	6		BAZ
SUPERIOR OIL	mineral oil	ai	Li	98.5	6		BAT
SUPRACIDE	methidathion	i	EC	240 g/L	2		NVT
tebufenozide	CONFIRM	i	FI	240 g/L	2		ROH



TABLE 13-1. Pesticides Used on Fruit Crops in Ontario (cont'd)

Common, Brand & Trade Names* (see end note)	Example of Brand Name* Products or Common or other name of active	Use**	Formu- lation ***	Guaranteed% active unless stated	Ont.Sch. (Table 13-2)	Winter Storage (see end note)	Man./ Agent's Code
TELONE C-17	dichloropropene + chloropicrin	bfhin	Li	78 + 14	2		DWE
TELONE II-B	dichloropropene	n	Li	94	2		DWE
terbacil	SINBAR	h	WP	80	2	C	DUQ
TERR-O-GAS 67	methyl bromide/ chloropicrin	h	Li	67 + 31	1		GLC
THIODAN	endosulfan	i	WP	50	2		ARV
thiophanate methyl	SENATOR	f	WP	70	2		ENG
THIRAM	thiram	f	WP	75	2		UNR
thiram	THIRAM	f	WP	75	2		UNR
TOPAS	propiconazole	f	EC	250 g/L	2		ENG
TOUCHDOWN 480	glyphosate TMS	h	Sn	330 g/L	6	B	ZNA
TREFLAN	trifluralin	h	EC	545 g/L	3	B	DWE
TREFLAN EC	trifluralin	h	EC	480 g/L	3	A	DWE
tri-basic copper sulphate	COPPER 53	b	WP	53	2		UAG
trifluralin	BONANZA 400	h	EC	400 g/L	3	B	UAG
trifluralin	RIVAL	h	EC	500 g/L	3	A	ARV
trifluralin	RIVAL DF	h	DF	60	2	C	ARV
trifluralin	TREFLAN	h	EC	545 g/L	3	B	DWE
trifluralin	TREFLAN EC	h	EC	480 g/L	3	A	DWE
triforine	FUNGINEX	f	EC	190 g/L	6		CYC
TROPOTOX PLUS	MCPB/MCPA	h	Sn	400 g/L	3	A	RHQ
VANGARD	cyprodinil	f	WG	75	3		NVT
VAPAM	metam sodium	bfhin	Sn	380 g/L	3	C	AMV
vinclozolin	RONILAN	f	DF	50	2		BAZ
VORLEX PLUS	methyl isothiocyanate + dichloropropene	bfhin	Li	203g + 373g/L	2	B	ARV
VORLEX PLUS CP	methyl isothiocyanate +dichloropropene + chloropicrin	bfhin	Li	185 g + 370 g + 163 g/L	2	B	ARV
VYDATE	oxamyl	in	Li	240 g/L	5		DUQ
water soluble dyes	AQUASHADE		Li	26	2	A	APB
WRANGLER	glyphosate	h	Sn	356 g/L	3	B	MOL
ZINEB	zineb	f	WP	80	3		WBR
zineb	ZINEB	f	WP	80	3		WBR
ZOLONE FLO	phosalone	i	FI	500	2		RHQ

## FOOTNOTES

\* Mention of a Brand or Trade name in this table does not constitute a guarantee of warranty of the product by the Ontario Weed Committee or the Ontario Crop Protection Committee. Neither does this use signify that these products are approved to the exclusion of comparable products. All trade names are capitalized.

\*\* a – acaricide, miticide      b – bactericide      f – fungicide  
h – herbicide      i – insecticide      n – nematocide  
r – rodenticide      x – repellent

\*\*\* symbols used are:

DC – dispersible concentrate      DF – dry flowable      DG – dry granules  
EC – emulsifiable concentrate      FI – flowable      Gr – Granule  
Li – liquid      SC – soluble concentrate      Sn – solution      SP – soluble powder  
Su – suspension (flowable)      WG – wettable granular      WP – wettable powder

#### Winter Storage:

- A – Do not allow to freeze.
- B – Preferably should not freeze. If frozen, return to original state by allowing product to warm up to 10°C to 20°C and agitate thoroughly before use.
- C – Not usually damaged by freezing. Store in a cool, dry place.
  - 1 – Store above 10°C
  - 2 – Store above 4°C
  - 3 – DF formulations packaged in water soluble film should not be moved while frozen

TABLE 13-2. Ontario Classification Schedules

Explanation of Schedules	
Listed below are the schedules in which the brand name products in Table 13-1 are classified under in the <i>Pesticides Act</i> .	
Schedule 1	Restricted, Use permit only.
Schedule 2	Restricted to certified agriculturists, licensed exterminators, registered custom sprayer and permit holders.
Schedule 3	Agriculturists and consumer use.
Schedule 4	Domestic products only.
Schedule 5	Limited to application on agricultural land. Similar to Schedule 2.
Schedule 6	Similar to Schedule 4 but may be registered for agricultural/commercial use; container size 1 L or greater.
For more information on the regulatory aspects of the classification, contact the Ministry of the Environment office nearest you.	

## Pesticide Notes

### Compatibility of Spray Materials

For information on compatibility of spray materials, **always check the product label**. Compatibility may refer to the physical or chemical compatibility of two products in solution.

**Physical incompatibility:** combinations result in a physical change in the solution. Components of the combined product may plug nozzles, or become solidified or gummy in the tank.

**Chemical incompatibility:** can result in chemical changes in the spray solution that can lead to reduced efficacy, or can cause plant injury when sprayed on the crop. The results of a chemical incompatibility may not be evident until after the spray is applied.

#### In general:

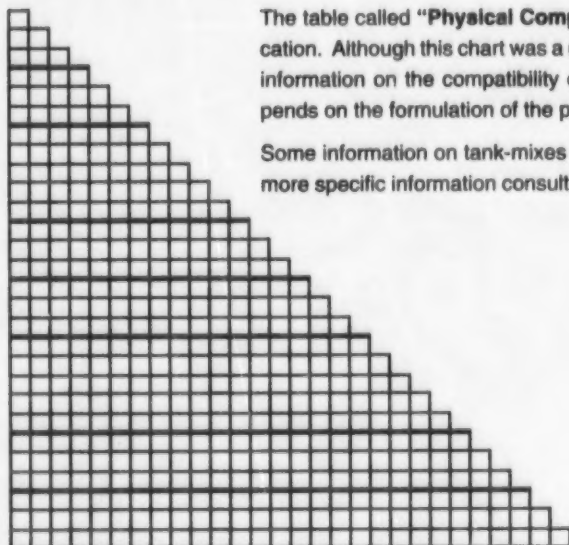
- Compatibility of 2 products may vary with the formulation of those products. For example, 2 products may be compatible as Wettable Powder (WP) formulations, but the same active ingredient may not be compatible as Emulsifiable Concentrate formulations (EC's).

- Compatibility generally refers to 2-way mixtures. Adding a third product to a tank mix, even if all are compatible with each other in 2-way combinations, may result in further incompatibility.
- Compatibility of some materials may depend on the solvents and emulsifiers used by the manufacturer. EC's are more likely to cause compatibility problems than WP's. If WP's are mixed with EC's, incompatibilities may result.

#### Specifically:

- When mixing Captan or Maestro with EC formulations of pyrethroids, add Captan or Maestro first. Apply immediately with constant agitation.
- Do not mix pesticides with lime sulfur or with Streptomycin.
- Oil sprays should not be used within 14 days of Captan, Maestro, Captan combinations or Morestan. This applies also to the oil used with Agri-mek.
- Water soluble, polyvinyl alcohol packaging (PVA) material is not compatible with Superior oil, or EC formulations containing mineral or vegetable oil products.

- Water-soluble packaging is not compatible with boron, and some chelated micronutrients or water soluble fertilizers. The spray tank should be carefully rinsed after application of these nutrients, before products in water-soluble packages are used.
- For more information on compatibility, contact the product manufacturer or dealer. See Table 13-1, *Pesticides Used on Fruit Crops in Ontario*, to find the manufacturer's/agent's code for the products you want to mix. Use Table 13-4, *Pesticide Manufacturers/Agents* to find contacts for more information.



The table called "**Physical Compatibility of Spray Materials**" has been deleted from this publication. Although this chart was a useful tool for growers, it is no longer possible to provide accurate information on the compatibility of pesticide combinations. Compatibility of spray materials depends on the formulation of the product, not the active ingredient.

Some information on tank-mixes of two or more products can be found on the product label. For more specific information consult the sales representative or dealer of the products you are using.

## **IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES**

**THE PAGES WHICH FOLLOW HAVE BEEN FILMED  
TWICE IN ORDER TO OBTAIN THE BEST  
REPRODUCTIVE QUALITY**

**USERS SHOULD CONSULT ALL THE PAGES  
REPRODUCED ON THE FICHE IN ORDER TO OBTAIN  
A COMPLETE READING OF THE TEXT.**

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## **REMARQUE IMPORTANTE CONCERNANT LES PAGES QUI SUIVENT**

**LES PAGES SUIVANTES ONT ÉTÉ REPRODUITES EN  
DOUBLE AFIN D'AMÉLIORER LA QUALITÉ DE  
REPRODUCTION**

**LES UTILISATEURS DOIVENT CONSULTER TOUTES  
LES PAGES REPRODUITES SUR LA FICHE AFIN  
D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL**

TABLE 13-3. Number of Days from Last Spray to Harvest

**Read the label and follow all safety precautions.**

Health Canada has established amounts of pesticides that may remain on fruits at time of harvest. To avoid exceeding these tolerances, use recommended amounts and do not spray nearer to harvest than number of days shown below, or not later than stage indicated. For tank mixes of 2 or more materials, use the longest period given for any of the materials. **Be aware that many processors may require longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Do not apply a pesticide more often than recommended on label.**

A within 14 days of petal fall	PH postharvest	— pesticide not recommended in this calendar on this crop
B not used alone	N No preharvest interval on label	
C Do not use later than recommended here	V vegetative year only	*5 days on sour cherry
PB prebloom	X no tolerance for pesticide on that fruit	**21 days on wine grapes

	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
2,4-D	80	80	80	80	80	—	N	N	—	—	—
Admire	7	—	—	—	—	—	—	—	—	—	—
Agri-mek	28	28	—	—	—	—	—	—	—	—	—
Allette	30	—	—	—	—	—	60	30	—	—	—
Amitrol - T	30	—	—	—	—	—	—	—	—	—	—
APM	7	7	15	21	15	28	3	—	—	—	14
Apollo	A	—	—	A	—	—	15	15	—	—	—
Benlate	1	A	1	1	1	1	1	1	1	—	—
Botran	—	—	—	1	—	—	—	—	—	—	—
Bravo	—	—	40	60	—	—	—	30	—	—	54
Captan	7	7	2*	2	2	7	2	2	2	—	2
Captan-benomyl	7	—	—	2	2	—	—	—	2	—	—
Carzol	1	1	—	21	—	—	—	—	—	—	—
Confirm	14	—	—	—	—	—	—	—	—	—	—
Copper 53	1	—	—	—	—	1	—	1	—	—	—
Cygon	14	14	15	—	X—	X—	X—	XC	—	—	15
Cymbush	7	7	—	7	—	7	—	7	—	—	—
Decis	1	7	—	7	—	—	—	14	—	—	14
Devrinol	N	N	V	N	V	N	N	N	V	—	70
Diazinon	14	14—	10	20—	10	16	X	5—	—	PB	—
Dikar	45	45	—	—	—	30	—	—	—	—	—
Dipel	1	1	—	—	—	—	—	—	—	—	—
Dithane DG	45	—	—	—	—	—	—	—	—	—	—
Dithane M-45	—	—	X—	X—	X—	30	X—	X—	X—	X—	X—
Elevate	—	—	—	—	—	7	—	1	—	—	—
Endosulfan	15	15	15	15	15	30	X—	7	—	—	—
Equal	—	7	7	—	X—	X—	X—	7	—	—	—
Ferbam	7	—	4	21	—	7	XC	—	21	14	40
Folpan	—	X—	—	X—	X—	1	—	1	—	—	—
Foray BA	1	1	—	—	—	—	1	—	—	—	—
Funginex	—	—	C	C	C	—	—	—	—	—	60
Furadan	—	—	—	—	—	—	—	XC	—	—	—
Fusilade II	N	N	N	N	N	—	N	30	30	—	30
Guthion	7	7	15	21	15	28	7	5	21	—	14
Hinder	14	14	14	14	14	14	14	14	14	14	14
Ignite	40	40	—	40	40	40	—	—	—	—	—



TABLE 13-3. Number of Days from Last Spray to Harvest (cont'd)

**Read the label and follow all safety precautions.**

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A within 14 days of petal fall	PH postharvest	— pesticide not recommended in this calendar on this crop
B not used alone	N No preharvest interval on label	
C Do not use later than recommended here	V vegetative year only	*5 days on sour cherry
PB prebloom	X no tolerance for pesticide on that fruit	**21 days on wine grapes

	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
Imidan	1	1	7	1	1	7	X—	X—	—	—	15
Kelthane	7	7	7	14	7	7	7	7	14	—	—
Lannate T-N-G	8	—	—	—	—	—	X—	—	—	—	—
Laredo	30	30	30	30	30	14	—	30	30	—	30
Lontrel	30	—	—	—	—	—	—	200	—	—	45
Lorsban	—	—	—	21	—	—	—	—	—	—	—
Maestro	7	7	2*	2	2	7	2	2	2	—	2
Malathion	3	—	3	—	3	—	1	3	7	3	1
Manzate 200	45	45	X—	X—	X—	30	X—	X—	—	—	—
Matador	7	7	7	7	7	—	—	7	—	—	—
Mitac	—	14	—	—	—	—	—	—	—	—	—
Nova	14	—	1	1	—	14	—	—	—	—	—
Nustar	77	—	—	—	—	—	—	—	—	—	—
Parathion	—	14	—	14	14	—	—	—	14	—	—
Penncozeb	45	—	—	—	—	—	—	—	—	—	—
Pirimor	35	—	—	60	—	—	—	—	—	—	—
Poast	N	N	N	N	N	—	—	—	N	—	15
Polyram	45	X—	—	X—	X—	45	X—	X—	—	—	—
Pounce	7	7	—	7	—	21	—	—	—	—	—
Pyramite	25	—	—	14	—	—	—	—	—	—	—
Renegade	30	30	30	30	30	14	—	30	30	—	30
Ridomil Gold	XC	—	—	—	—	—	XC	XC	—	—	—
Ridomil GoldMZ	XC	—	—	—	—	66	XC	XC	—	—	—
Ridomil/Copper	—	—	—	—	—	66	—	—	—	—	—
Ripcord	7	7	—	—	—	—	—	7	—	—	—
Ronilan	—	—	—	—	—	—	—	3	—	—	—
Roundup	30	30	30	30	30	14	—	30	30	—	30
Rovral	—	—	1	1	1	7	1	1	1	—	—
Senator	B7	—	—	—	—	—	1	—	—	—	—
Sevin XLR plus	11	11	2	1	2	5	—	2	5	—	2
Sniper	7	7	15	21	15	28	7	5	21	—	14
Streptomycin 17	50	30	—	—	15	—	—	—	—	—	—
Sulphur, Kumulus	1	1	1	1	1	1**	—	—	—	1	—
Supracide	XC	—	—	—	—	—	—	—	—	—	—
Thiodan	15	15	15	15	15	30	X—	7	—	—	—
Topas	—	—	3	3	3	—	—	—	3	—	60

TABLE 13-3. Number of Days from Last Spray to Harvest

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B not used alone	N No preharvest interval on label	
C Do not use later than recommended here	V vegetative year only	*5 days on sour cherry
PB prebloom	X no tolerance for pesticide on that fruit	**21 days on wine grapes

	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
2,4-D	80	80	80	80	80	—	N	N	—	—	—
Admire	7	—	—	—	—	—	—	—	—	—	—
Agri-mek	28	28	—	—	—	—	—	—	—	—	—
Aliette	30	—	—	—	—	—	60	30	—	—	—
Amitrol - T	30	—	—	—	—	—	—	—	—	—	—
APM	7	7	15	21	15	28	3	—	—	—	14
Apollo	A	—	—	A	—	—	15	15	—	—	—
Benlate	1	A	1	1	1	1	1	1	1	—	—
Botran	—	—	—	1	—	—	—	—	—	—	—
Bravo	—	—	40	60	—	—	—	30	—	—	54
Captan	7	7	2*	2	2	7	2	2	2	—	2
Captan-benomyl	7	—	—	2	2	—	—	—	2	—	—
Carzol	1	1	—	21	—	—	—	—	—	—	—
Confirm	14	—	—	—	—	—	—	—	—	—	—
Copper 53	1	—	—	—	—	1	—	1	—	—	—
Cygon	14	14	15	—	X—	X—	X—	XC	—	—	15
Cymbush	7	7	—	7	—	7	—	7	—	—	—
Decis	1	7	—	7	—	—	—	14	—	—	14
Devrinol	N	N	V	N	V	N	N	N	V	—	70
Diazinon	14	14—	10	20—	10	16	X	5—	—	PB	—
Dikar	45	45	—	—	—	30	—	—	—	—	—
Dipel	1	1	—	—	—	—	—	—	—	—	—
Dithane DG	45	—	—	—	—	—	—	—	—	—	—
Dithane M-45	—	—	X—	X—	X—	30	X—	X—	X—	X—	X—
Elevate	—	—	—	—	—	7	—	1	—	—	—
Endosulfan	15	15	15	15	15	30	X—	7	—	—	—
Equal	—	7	7	—	X—	X—	X—	7	—	—	—
Ferbam	7	—	4	21	—	7	XC	—	21	14	40
Folpan	—	X—	—	X—	X—	1	—	1	—	—	—
Foray BA	1	1	—	—	—	—	1	—	—	—	—
Funginex	—	—	C	C	C	—	—	—	—	—	60
Furadan	—	—	—	—	—	—	—	XC	—	—	—
Fusilade II	N	N	N	N	N	—	N	30	30	—	30
Guthion	7	7	15	21	15	28	7	5	21	—	14
Hinder	14	14	14	14	14	14	14	14	14	14	14
Ignite	40	40	—	40	40	40	—	—	—	—	—

TABLE 13-3. Number of Days from Last Spray to Harvest (cont'd)

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	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
Imidan	1	1	7	1	1	7	X—	X—	—	—	15
Kelthane	7	7	7	14	7	7	7	7	14	—	—
Lannate T-N-G	8	—	—	—	—	—	X—	—	—	—	—
Laredo	30	30	30	30	30	14	—	30	30	—	30
Lontrel	30	—	—	—	—	—	—	200	—	—	45
Lorsban	—	—	—	21	—	—	—	—	—	—	—
Maestro	7	7	2*	2	2	7	2	2	2	—	2
Malathion	3	—	3	—	3	—	1	3	7	3	1
Manzate 200	45	45	X—	X—	X—	30	X—	X—	—	—	—
Matador	7	7	7	7	7	—	—	7	—	—	—
Mitac	—	14	—	—	—	—	—	—	—	—	—
Nova	14	—	1	1	—	14	—	—	—	—	—
Nustar	77	—	—	—	—	—	—	—	—	—	—
Parathion	—	14	—	14	14	—	—	—	14	—	—
Penncozeb	45	—	—	—	—	—	—	—	—	—	—
Pirimor	35	—	—	60	—	—	—	—	—	—	—
Poast	N	N	N	N	N	—	—	—	N	—	15
Polyram	45	X—	—	X—	X—	45	X—	X—	—	—	—
Pounce	7	7	—	7	—	21	—	—	—	—	—
Pyramite	25	—	—	14	—	—	—	—	—	—	—
Renegade	30	30	30	30	30	14	—	30	30	—	30
Ridomil Gold	XC	—	—	—	—	—	XC	XC	—	—	—
Ridomil GoldMZ	XC	—	—	—	—	66	XC	XC	—	—	—
Ridomil/Copper	—	—	—	—	—	66	—	—	—	—	—
Ripcord	7	7	—	—	—	—	—	7	—	—	—
Ronilan	—	—	—	—	—	—	—	3	—	—	—
Roundup	30	30	30	30	30	14	—	30	30	—	30
Rovral	—	—	1	1	1	7	1	1	1	—	—
Senator	B7	—	—	—	—	—	1	—	—	—	—
Sevin XLR plus	11	11	2	1	2	5	—	2	5	—	2
Sniper	7	7	15	21	15	28	7	5	21	—	14
Streptomycin 17	50	30	—	—	15	—	—	—	—	—	—
Sulphur, Kumulus	1	1	1	1	1	1**	—	—	—	1	—
Supracide	XC	—	—	—	—	—	—	—	—	—	—
Thiodan	15	15	15	15	15	30	X—	7	—	—	—
Topas	—	—	3	3	3	—	—	—	3	—	60



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	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
Touchdown	30	30	30	30	30	14	—	30	30	—	30
Vanguard	72	—	—	2	2	7	—	—	2	—	—
Wrangler	30	30	30	30	30	14	—	30	30	—	30
Zineb	45	45	—	—	—	—	—	—	—	—	—
Zolone Flo	30	—	14	—	—	—	—	—	—	—	—

TABLE 13-4. Pesticide Manufacturers/Agents

ABT	ABBOTT LABORATORIES LTD	1-905-659-0886
AMV	AMVAC CHEMICALS CORP.	1-323-264-3910
ARV	AGREVO CANADA INC.	1-800-667-5959
APB	APPLIED BIOCHEMISTS INC.	1-800-558-5106
BAT	BARTLETT, N.M. INC.	1-800-565-9586
BBB	BAYER INC.	1-800-268-1331
BAZ	BASF CANADA INC.	1-416-674-2825
CNV	CHEMINOVA	1-888-316-6260
CYC	CYANAMID CANADA INC.	1-800-263-1228
DWE	DOW AGRO SCIENCE CANADA	1-800-667-3852
DUQ	DUPONT CANADA INC.	1-800-667-3925
EFA	ELF ATOCHEM OF CANADA	1-905-827-9841
ENG	ENGAGE AGRO CORP.	1-519-826-7878
GLC	GREAT LAKES CHEMICAL CORP	1-800-428-7947
GOW	GOWAN COMPANY	1-520-783-8844
GRN	GRIFFIN CORP.	1-912-242-8635
HOK	HACCO INC.	1-608-221-6200
INT	INTERPROVINCIAL COOP LTD.	1-204-233-3461
LPH	LIPHA TECH	1-414-351-1476
MKC	MAKHTESHIM AGAN N.A.	1-416-233-1496
MOL	MONSANTO CANADA LTD.	1-800-361-2405
NRA	NORAC CONCEPTS INC.	1-613-841-2907
NUF	NUFARM	1-800-868-5444
NUG	NU-GRO CORP.	1-519-757-0077
NVT	NOVARTIS CROP PROTECTION	1-800-459-2422
RHQ	RHONE-POULENC CANADA INC	1-800-891-8291
ROH	ROHM & HAAS CANADA INC.	1-800-268-4201
TOA	TOMEN AGRO INC.	1-415-536-3480
UNR	UNIROYAL CHEMICAL LTD.	1-800-265-2157
UAG	UNITED AGRI PRODUCTS	1-800-265-4624
WBR	WILBUR-ELLIS CO. CANADA	1-559-442-1220
ZNA	ZENECA AGRO	1-800-263-8308



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	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
Touchdown	30	30	30	30	30	14	—	30	30	—	30
Vanguard	72	—	—	2	2	7	—	—	2	—	—
Wrangler	30	30	30	30	30	14	—	30	30	—	30
Zineb	45	45	—	—	—	—	—	—	—	—	—
Zolone Flo	30	—	14	—	—	—	—	—	—	—	—

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BAZ	BASF CANADA INC.	1-416-674-2825
CNV	CHEMINOVA	1-888-316-6260
CYC	CYANAMID CANADA INC.	1-800-263-1228
DWE	DOW AGRO SCIENCE CANADA	1-800-667-3852
DUQ	DUPONT CANADA INC.	1-800-667-3925
EFA	ELF ATOCHEM OF CANADA	1-905-827-9841
ENG	ENGAGE AGRO CORP.	1-519-826-7878
GLC	GREAT LAKES CHEMICAL CORP	1-800-428-7947
GOW	GOWAN COMPANY	1-520-783-8844
GRN	GRIFFIN CORP.	1-912-242-8635
HOK	HACCO INC.	1-608-221-6200
INT	INTERPROVINCIAL COOP LTD.	1-204-233-3461
LPH	LIPHA TECH	1-414-351-1476
MKC	MAKHTESHIM AGAN N.A.	1-416-233-1496
MOL	MONSANTO CANADA LTD.	1-800-361-2405
NRA	NORAC CONCEPTS INC.	1-613-841-2907
NUF	NUFARM	1-800-868-5444
NUG	NU-GRO CORP.	1-519-757-0077
NVT	NOVARTIS CROP PROTECTION	1-800-459-2422
RHQ	RHONE-POULENC CANADA INC	1-800-891-8291
ROH	ROHM & HAAS CANADA INC.	1-800-268-4201
TOA	TOMEN AGRO INC.	1-415-536-3480
UNR	UNIROYAL CHEMICAL LTD.	1-800-265-2157
UAG	UNITED AGRI PRODUCTS	1-800-265-4624
WBR	WILBUR-ELLIS CO. CANADA	1-559-442-1220
ZNA	ZENECA AGRO	1-800-263-8308

# Appendices

## APPENDIX A. Accredited Soil Testing Laboratories

The following labs are accredited to perform soil tests for pH, buffer pH, P, K, Mg and Nitrate-N on Ontario soils.

Company	Address	Contact
A & L Canada Laboratories East, Inc. 2136 Jetstream Road London, Ontario N5V 3P5	Tel (519)457-2575 Fax (519) 457-2664 web site <a href="http://www.al-labs-can.com">www.al-labs-can.com</a> email <a href="mailto:aginfo@al-labs-can.com">aginfo@al-labs-can.com</a>	Mr. Greg Patterson Mr. Ian McLachlin
Accutest Laboratories 146 Colonnade Road, Unit #8 Nepean, Ontario K2E 7Y1	Tel (613) 727-5692 Fax (613) 727-5222 web site <a href="http://www.accutestlabs.com">www.accutestlabs.com</a> email <a href="mailto:phaulena@accutestlabs.com">phaulena@accutestlabs.com</a>	Mrs. Lorna Wilson Mr. Peter Haulena
Agri-Food Laboratories 503 Imperial Road, Unit #1 Guelph, Ontario N1H 6T9	Tel (519) 837-1600, 1-800-265-7175 Fax (519) 837-1242 web site: <a href="http://www.agtest.com">www.agtest.com</a> email <a href="mailto:lab@agtest.com">lab@agtest.com</a>	Mr. Dale Cowan Ms. Nora Wilson
Soil and Nutrient Laboratory (formerly Analytical Services, Land Resource Science) University of Guelph P.O. Box 3650, 95 Stone Road West Guelph, Ontario N1H 8J7	Tel (519) 767-6226 Fax (519) 767-6240 email <a href="mailto:vkerslak@lsd.uoguelph.ca">vkerslak@lsd.uoguelph.ca</a>	
Stratford Agri Analysis Inc. (A Daco Laboratories Ltd. company) 1131 Erie Street, Box 760 Stratford, Ontario N5A 6W1	Tel (519) 273-4411, 1-800-323-9089 Fax (519) 273-4411 email <a href="mailto:saa@dacolabs.com">saa@dacolabs.com</a>	Mr. Dale Peters Mr. Gary Roberts Mr. Keith Lemp

## APPENDIX B. Ontario Ministry of the Environment Pesticides Control Offices

Region/County	Pesticides Officer Address	Telephone/Fax	
<b>Central Region</b> Toronto, Halton, Peel, York, Durham	Charles Zubovits 5775 Yonge Street, 8th Floor Toronto, Ontario M2M 4J1	Tel	(416) 326-3671 Toll Free 1-800-810-8048 Fax (416) 325-6347
<b>West-Central Region</b> Haldimand-Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Paul McCubbin Linda Dennie Ontario Government Building 119 King Street West, 12th Floor Hamilton, Ontario L8N 3Z9	Tel	(905) 521-7667 (905) 521-7658 Fax (905) 521-7820
<b>Eastern Region</b> Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Peterborough, Victoria, Northumberland, Renfrew, Ottawa- Carleton, Lanark, District of Nipissing (Townships of Airy, Murchison, Dickens, Lyell and Sabine)	Andrew Morley 133 Dalton Avenue Kingston, Ontario K7L 4X6	Tel	(613) 549-4000, ext 2684 Fax (613) 548-6908 Toll Free 1-800-267-0974
<b>Southwestern Region</b> Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth, Simcoe	Doug Morrow Wray Lampman 659 Exeter Road, 2nd Floor London, Ontario N6E 1L3	Tel	(519) 873-5047 (519) 873-5048 Fax (519) 873-5000
<b>Northern Region</b> Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma East, Cochrane East, Haliburton, Muskoka, Kenora, Rainy River, Thunder Bay, Algoma West, Cochrane West	Ray Potvin John Negusanti 199 Larch Street, Suite 1101 Sudbury, Ontario P3E 5P9	Tel	(705) 564-3247 (705) 564-3249 Fax (705) 564-4180
<b>Standards Development Branch</b>	Pesticides Section (Mailing Address) 135 St. Clair Avenue West Toronto, Ontario M4V 1P5	Tel	(416) 327-5519 Fax (416) 327-2936
<b>Approvals Branch</b>	Pesticides Licensing 250 Davisville Avenue, 3rd Floor Toronto, Ontario M4S 1H2	Tel	(416) 440-3584 Toll Free 1-800-461-6290 Fax (416) 440-6973

## APPENDIX C. Other Contacts

### **Agriculture & Agri-Food Canada Research Centres**

#### *Eastern Cereals and Oilseeds Research Centre*

960 Carling Avenue  
Ottawa, K1A 0C6  
Tel (613) 759-1952

#### *Greenhouse and Processing Crops Centre*

Harrow N0R 1G0  
Tel (519) 738-2251

#### *Southern Crop Protection and Food Research Centre*

1391 Sandford Street  
London N5V 4T3  
Tel (519) 457-1470

#### *Vineland Research Farm*

4902 Victoria Avenue North  
Vineland L0R 2E0  
Tel (905) 562-4113

#### *Delhi Research Farm*

Box 186 Schafer Road  
Delhi N4B 2W9  
Tel (519) 582-1950

### **Canadian Food Inspection Agency Regional Offices (Plant Protection)**

#### *Belleville, 345 Collège Street East*

Belleville, K8N 5S7  
Tel (613) 969-3333

#### *Brantford, Federal Building, Dalhousie & Queen St., P.O. Box 637*

Brantford, N3T 5P9  
Tel (519) 751-8157

#### *Hamilton, 709 Main Street West, Suite 101*

Hamilton, L8S 1A2  
Tel (905) 572-4152

#### *London, 457 Richmond Street, Suite 404*

London, N6A 3E3  
Tel (519) 645-4021

#### *Niagara Falls*

Mailing address: P.O. Box 35, Niagara Falls, L2E 6S9  
Street address: 4551 Zimmerman Avenue  
Niagara Falls, L2E 3M5  
Tel (905) 357-5981

#### *Ottawa District*

3 Observatory Crescent

#### *Building #3 Central, Experimental Farm*

Ottawa, K1A 0C9  
Tel (613) 759-1571

#### *Toronto, 401 Champagne Drive, Unit 1*

Downsview, M3J 2C6  
Tel (416) 954-1714

#### *Windsor, 441 University Avenue West, Suite 208*

Windsor, N9A 5P9  
Tel (519) 252-7095

### **University of Guelph**

#### *Main Campus, Guelph, N1G 2W1*

Tel (519) 824-4120

#### *Alfred College, Alfred, K0B 1A0*

Tel (613) 679-2218

#### *Kemptville College, Kemptville, K0G 1J0*

Tel (613) 258-8336

#### *Ridgetown College, Ridgetown, N0P 2C0*

Tel (519) 674-1500

#### *Department of Plant Agriculture, Kettleby*

1125 Woodchopper's Lane, R.R. # 1  
Kettleby, L0G 1J0  
Tel (905) 775-3783

#### *Department of Plant Agriculture, Simcoe*

Box 587 Blue Line Road  
Simcoe, N3Y 4N5  
Tel (519) 426-7127

#### *Department of Plant Agriculture, Vineland*

Box 7000, 4890 Victoria Avenue North  
Vineland Station, L0R 2E0  
Tel (905) 562-4141

### **Lab Services Division**

#### *Pesticide and Trace Contaminants*

P.O. Box 3650, 95 Stone Road West  
Guelph, N1H 8J7  
Tel (519) 767-6200

#### *Pest Diagnostic Clinic*

Tel (519) 767-6256

## APPENDIX D. List of Monitoring Equipment and Biological Agent Suppliers

The following is a partial list of suppliers of IPM monitoring equipment, including weather machines, monitoring equipment, and biological control agents.

**Note:** Inclusion in this list of companies does not imply any endorsement or recommendation by the Ontario Ministry of Agriculture, Food and Rural Affairs.

Company		Products
Cooper Mill Ltd. R.R. # 3 Madoc, Ontario K0K 2K0	Phone: (613) 473-4847 Fax: (613) 473-5080 Email: ipm@telos.ca	Pheromone lures and traps
Gempler's 100 Countryside Drive, P. O. Box 270 Belleville, Wisconsin 53508	Phone: 1-800-382-8473 Fax: 1-800-551-1128	Weather monitoring equipment Pheromone lures and traps Apple maggot spheres Tangle trap Magnifiers Tally counters Field diagnostic equipment
Great Lakes IPM 10220 Church Road NE Vestaburg, Michigan 48891	Phone: (517) 268-5693 Fax: (517) 268-5311 Email: glipm@nethawk.com	Weather monitoring equipment Pheromone lures and traps Apple maggot spheres Tangle trap Magnifiers Tally counters Field diagnostic equipment
Natural Insect Control R.R. # 2 Stevensville, Ontario L0S 1S0	Phone: (905) 382-2904 Fax: (905) 382-4418 Email: nic@niagara.com	Beneficial insects and mites Pheromone lures and traps Apple maggot spheres Tangle trap Bird houses
Plant Products Co. Ltd. 314 Orenda Rd. East Brampton, Ontario L6T 1G1	Phone: 1-800-387-2449 Fax: (905) 793-9157	Beneficial insects and mites Pheromone traps and lures Magnifiers Field diagnostic equipment
Solida Distributions 480 Rang St-Antoine St-Ferred-Les-Neiges, Quebec G0A 3R0	Phone: (418) 826-0900 Fax: (418) 826-0901 Email: solida@clic.net	Pheromone traps and lures Tangle trap Magnifiers Tally counters Apple maggot spheres
Warwick Orchards and Nursery R.R. # 8 Wattford, Ontario N0M 2S0	Phone: (519) 849-6730 Fax: (519) 849-6731	Dewit leaf wetness sensors



## APPENDIX E. Diagnostic Service

Samples for disease diagnosis, insect or weed identification, nematode counts and Verticillium testing can be sent to:

### Pest Diagnostic Clinic

Laboratory Services Division  
University of Guelph  
95 Stone Road West  
Guelph Ont.ario, N1H 8J7  
Tel (519) 767-6256  
Fax (519) 767-6240  
E-mail pdc@lsd.uoguelph.ca  
Web site www.uoguelph.ca/pdc

Payment must accompany samples at the time of submission.

Please make cheque payable to the University of Guelph. Additional charges will be invoiced with the final report. VISA and Mastercard are also accepted. Please do not mail cash

### Fee Schedule

Procedures	Price/ Sample
<b>Plant Diseases</b>	
Diagnosis not requiring plating	\$25.00
Diagnosis requiring plating	\$40.00
Turf diagnosis	\$50.00
Bacterial identification using Biolog®	\$95.00
Detection of virus using Transmission Electron Microscopy	\$85.00
Detection of virus using ELISA (turnaround time = 5 working days)	\$60.00
Detection of virus using ELISA (RUSH: 24-hour turnaround. Available for samples received Monday through Thursday. Each additional sample is \$20.00. ELISA tests not available for all viruses, contact clinic staff for details.)	\$120 for 1–6 samples
Weed identification	\$40.00
<b>Insects</b>	
Basic identification	\$25.00
Identification requiring dissection and/or extensive keys	\$40.00
<b>Nematode and Verticillium Counts</b>	
Nematodes extracted from soil (Bearman Pan Method)	\$25.00
Nematodes extracted from roots	\$60.00
Verticillium count	\$60.00
SCN cyst count + egg count	\$35.00

A minimum fee of \$25.00 should accompany all submissions.

## How to Sample for Nematodes

### Soil

#### When to Sample

Soil and root samples can be taken at any time of the year that the soil is not frozen. In Ontario, nematode soil population levels are generally at their highest in May and June and again in September and October.

#### How to Sample Soil

Use a soil sampling tube, trowel or narrow-bladed shovel to take samples. Sample soil to a depth of 20–25 cm (8–10 in.). If the soil is bare, remove the top 2 cm (1 in.) prior to sampling. A sample should consist of 10 or more subsamples combined. Mix well. Then take a sample of 1/2–1 L (1 pint–1 quart) from this. No one sample should represent more than 2.5 ha (6.25 ac). Mix subsamples in a clean pail or plastic bag.

#### Sampling Pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees, this is the drip line).

#### Number of Subsamples

Based on the total area sampled:

500 m <sup>2</sup> (5,400 ft <sup>2</sup> )	10 subsamples
500 m <sup>2</sup> –0.5 ha (5,400 ft <sup>2</sup> –1.25 ac)	25 subsamples
0.5 ha–2.5 ha (1.25–6.25 ac)	50 subsamples

#### Roots

From small plants, sample the entire root system plus adhering soil. For large plants, 10–20 g (1/2–1 oz.) dig fresh weight from the feeder root zone and submit.

#### Problem Areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take samples from healthy areas in the same field. If possible, take both soil and root samples from problem and healthy areas in the same field.

#### Sample Handling

##### Soil Samples

Place in plastic bags as soon as possible after collecting.

##### Root Samples

Place in plastic bags and cover with moist soil from the sample area.

##### Storage

Store samples at 5–10°C (40–50°F) and do not expose them to direct sunlight or extreme heat or cold (freezing). **Only living nematodes can be counted. Accurate counts depend on proper handling of samples.**

## Submitting Plant for Disease Diagnosis or Identification

### Sample Submission Forms

Carefully fill in all of the categories on the form. In the space provided, draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past 3 years and this year's pesticide use records.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. For turfgrass, submit a 10–15 cm<sup>2</sup> piece of turf, including thatch and at least 5 cm of soil. Take the sample from the outside edge of a ring or patch, and include healthy and unhealthy turf, as well as the interface between. If symptoms are general, collect the sample from an area where they are of intermediate severity. **Completely dead material is usually inadequate for diagnosis.**

With plant specimens submitted for identification, include at least a 20–25-cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to avoid drying out and contamination of the

leaves by soil. Do **NOT** add moisture, as this encourages decay in transit. Cushion specimens and pack in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

### Delivery

Deliver to the Pest Diagnostic Clinic as soon as possible by first class mail or by courier at the beginning of the week.

## Submitting Insect Specimens for Identification

### Collecting Samples

Place dead, hard-bodied insects and spiders in vials or boxes and cushion with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant "food" to support them during transit. Be sure to write "live" on the outside of the container.

The Canada-Ontario Crop Insurance Program is publicly funded by the Canadian and Ontario governments, and delivered by AGRICORP. The federal and provincial governments each contribute 25 per cent of the premium cost and 50 per cent of the administrative costs. Both these contributions enable an Ontario grower to purchase insurance coverage at a substantially reduced cost.

The growers payment is considered an operating expense for income tax purposes. Crop insurance offers protection against a broad range of production hazards, including excessive rain, hail, excessive drought, freeze, frost, excessive wind and certain insects and diseases.

For further information, contact your Territory Sales Manager:

**AGRICORP**  
 1 Stone Road West  
 Box 3660, Station Central  
 Guelph, ON N1H 8M4  
 519-826-3276  
**1-888-247-4999**  
[www.agricorp.com](http://www.agricorp.com)

**Ontario Crops Covered by a Crop Insurance Plan**

<b>Fruit Crops</b>	<b>Vegetables</b>	<b>General Crops</b>	<b>Tobacco</b>
Apples (fruit and/or trees)	Asparagus	Beans, coloured	Black
Cherries, sweet and sour	Beans (green and wax, processing only)	Beans, white	Flue-cured
Grapes (fruit and/or vines)	Beets (processing only)	Canola	
Peaches (including nectarines)	Broccoli	Corn (grain and silage)	
Pears	Cabbage	Corn, seed	
Plums	Carrots (fresh and processing)	Forage	
Strawberries	Cauliflower	Forage, seeding, new	
	Celery	Honey	
	Cucumbers (processing only)	Industrial Hemp	
	Lettuce	Peanuts	
	Lima Beans (processing only)	Popcorn	
	Parsnips	Soybeans	
	Peas (processing only)	Spring grain	
	Peppers	Sugar beets	
	Potatoes	Sunflowers	
	Rutabagas	Wheat, red spring	
	Seed Onions	Wheat, winter	
	Set Onions		
	Spanish Onions		
	Squash (butternut, processing)		
	Sweet corn (fresh and processing)		
	Tomatoes (processing)		

Insurance contracts for all other crops are available from AGRICORP Territory Sales Managers.

## APPENDIX G. The Metric System

### Metric Units

<b>Linear Measures (length)</b>		
10 millimetres (mm)	=	1 centimetre (cm)
100 centimetres (cm)	=	1 metre (m)
1,000 metres	=	1 kilometre (km)
<b>Square Measures (area)</b>		
100 m X 100 m = 10,000 m <sup>2</sup>	=	1 hectare (ha)
100 ha	=	1 square kilometre (km <sup>2</sup> )
<b>Cubic Measures (volume)</b>		
<i>Dry Measure</i>		
1,000 cubic millimetres (mm <sup>3</sup> )	=	1 cubic centimetre (cm <sup>3</sup> )
1,000,000 cm <sup>3</sup>	=	1 cubic metre (m <sup>3</sup> )
<i>Liquid Measure</i>		
1,000 millilitres (mL)	=	1 litre (L)
100 L	=	1 hectolitre (hL)
<b>Weight-Volume Equivalents (for water)</b>		
(1.00 kg) 1,000 grams	=	1 litre (1.00 L)
(0.50 kg) 500 g	=	500 mL (0.50 L)
(0.10 kg) 100 g	=	100 mL (0.10 L)
(0.01 kg) 10 g	=	10 mL (0.01 L)
(0.001 kg) 1 g	=	1 mL (0.001 L)
<b>Weight Measures</b>		
1,000 milligrams (mg)	=	1 gram (g)
1,000 g	=	1 kilogram (kg)
1,000 kg	=	1 tonne (t)
1 mg/kg	=	1 part per million (ppm)
<b>Dry-Liquid Equivalents</b>		
1 cm <sup>3</sup>	=	1 mL
1 m <sup>3</sup>	=	1000 L

### Application Rate Conversations

<b>Metric to Imperial (Approximate)</b>		
litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

<b>Imperial to Metric (Approximate)</b>		
gallons per acre x 11.23	=	litres per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
ounces per acre x 70	=	grams per hectare (g/ha)

<b>Liquid Equivalents</b>		
<i>Litres/Hectare</i>		<i>Approximate Gallons/Acre</i>
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

<b>Dry Weight Equivalents</b>		
<i>Grams or Kilograms / Hectare</i>		<i>Ounces or Pounds /Acre</i>
100 grams	=	1 1/2 ounces
200 grams	=	3 ounces
300 grams	=	4 1/4 ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1 1/4 pounds
2.00 kilograms	=	1 3/4 pounds
2.50 kilograms	=	2 1/4 pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3 1/2 pounds
5.00 kilograms	=	4 1/2 pounds
6.00 kilograms	=	5 1/4 pounds
7.50 kilograms	=	6 3/4 pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11 1/2 pounds
15.0 kilograms	=	13 1/2 pounds

<b>Metric Conversions</b>		
5 mL	=	1 tsp
15 mL	=	1 tbsp
28.5 mL	=	1 fl. oz

## Conversion Tables — Metric to Imperial

Length		
1 millimetre (mm)	=	0.04 inch
1 centimetre (cm)	=	0.40 inch
1 metre (m)	=	39.40 inches
1 metre (m)	=	3.28 feet
1 metre (m)	=	1.09 yards
1 kilometre (km)	=	0.62 mile

Area		
1 square centimetre (cm <sup>2</sup> )	=	0.16 square inch
1 square metre (m <sup>2</sup> )	=	10.77 square feet
1 square metre (m <sup>2</sup> )	=	1.20 square yards
1 square kilometre (km <sup>2</sup> )	=	0.39 square mile
1 hectare (ha)	=	107,636 square feet
1 hectare (ha)	=	2.5 acres

Volume (dry)		
1 cubic centimetre (cm <sup>3</sup> )	=	0.061 cubic inch
1 cubic metre (m <sup>3</sup> )	=	1.31 cubic yards
1 cubic metre (m <sup>3</sup> )	=	35.31 cubic feet
1,000 cubic metres (m <sup>3</sup> )	=	0.81 acre-foot
1 hectolitre (hL)	=	2.8 bushels

Volume (liquid)		
1 millilitre (mL)	=	0.035 fluid ounce
1 litre (L)	=	1.76 pints
1 litre (L)	=	0.88 quart
1 litre (L)	=	0.22 gallon (Imp.)
1 litre (L)	=	0.26 gallon (U.S.)

Weight		
1 gram (g)	=	0.035 ounce
1 kilogram (kg)	=	2.21 pounds
1 tonne (t)	=	1.10 short tons
1 tonne (t)	=	2,205 pounds

Pressure		
1 kilopascal (kPa)	=	0.15 pounds/in <sup>2</sup>

Speed		
1 metre per second	=	3.28 feet per second
1 metre per second	=	2.24 miles per hour
1 kilometre per hour	=	0.62 mile per hour

Temperature		
°F	=	(°C X 9/5) + 32

## Conversion Tables — Imperial to Metric

Length		
1 inch	=	2.54 cm
1 foot	=	0.30 m
1 yard	=	0.91 m
1 mile	=	1.61 km

Area		
1 square foot	=	0.09 m <sup>2</sup>
1 square yard	=	0.84 m <sup>2</sup>
1 acre	=	0.40 ha

Volume (dry)		
1 cubic yard	=	0.76 m <sup>3</sup>
1 bushel	=	36.37 L

Volume (liquid)		
1 fluid ounce (Imp.)	=	28.41 mL
1 pint (Imp.)	=	0.57 L
1 gallon (Imp.)	=	4.55 L
1 gallon (U.S.)	=	3.79 L

Weight		
1 ounce	=	28.35 g
1 pound	=	453.6 g
1 ton	=	0.91 tonne

Pressure		
1 pound per square inch	=	6.90 kPa

Temperature		
°C	=	(°F - 32) x 5/9

## Abbreviations

%	= per cent (by weight)	km/h	= kilometres per hour
ai	= active ingredient	kPa	= kilopascal
AP	= agricultural powder	L	= litre
cm	= centimetre	m	= metre
cm <sup>2</sup>	= square centimetre	m/s	= metres per second
DG	= dispersible granular	m <sup>2</sup>	= square metre
DP	= dispersible powder	mL	= millilitre
E	= emulsifiable	mm	= millimetre
e.g.	= for example	SC	= sprayable concentrate
EC	= emulsifiable concentrate	SP	= soluble powder
F	= flowable	t	= tonne
g	= gram	W	= wettable (powder)
Gr	= granules, granular	WDG	= water dispersible granular
ha	= hectare	WP	= wettable powder
kg	= kilogram	km/h	= kilometres per hour



### Spraying Record

[illegible]

## **Emergency and First-Aid Procedures for Pesticide Poisoning**

- Become familiar with the chemicals you are using. Keep a list of common names in case of accidents or emergencies. This information can be found on the product labels and cross-referenced in this publication.
- If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water.
- If pesticide has come in contact with the eyes, rinse them with plenty of clean water for 15 minutes. Repeat this procedure.
- If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.
- **Immediately after first-aid treatment has been given, wrap the patient in a coat or blanket and rush him/her to the nearest hospital. Take the list of chemical common names with you and identify the ones being used.**
- **If a person is unconscious or lapses into unconsciousness, call an ambulance immediately.**
- **Emergency advice on pesticide poisoning is available from the Regional Poison Information Centres at:**  
**Toronto 1-800-268-9017   Ottawa (bilingual) 1-800-267-1373**
- **Those needing hearing assistance should call: 1-416-597-0215 (TTY)**

**Emergency telephone numbers are listed at the front of each Bell telephone directory.**

**Fill in the following:**

**My Local Poison Information Centre Telephone Number is:**

\_\_\_\_\_ - \_\_\_\_\_

For information, or to obtain copies of this or any other ministry publication, please: call 1-888-4-OMAFRA (1-888-466-2372) from within Ontario, (519) 826-3700 from outside the province or OMAFRA's TTY line at (519) 826-7402 for the hearing impaired, email your request to [products@omafra.gov.on.ca](mailto:products@omafra.gov.on.ca), or visit OMAFRA's web site at [www.gov.on.ca/omafra](http://www.gov.on.ca/omafra).

A complete listing of all OMAFRA products and services, and order forms, are available on the web site. Orders can be faxed to (519) 826-3633 or mailed to Government Information Centre, OMAFRA, 1 Stone Road West, Guelph, ON N1G 4Y2